# JOURNAL OF MAMMALOGY

Published Quarterly by the American Society of Mammalogists

VOL. 8 FEBRUARY, 1927 No. 1

## ECOLOGY OF THE RED SQUIRREL[1]

BY A. BROOKER KLUGH

[*Plates 1–5*]

### INTRODUCTION

The red squirrel (*Sciurus hudsonicus* and subspecies) is one of the commonest and most generally known mammals over a large part of North America. Under the name "*Adjidomo*" it has figured in Ojibwa and Cree myths and in Longfellow's "Hiawatha," and by the name of chickaree, common squirrel, barking squirrel, red squirrel, and l'ecureil rouge, it has been cited in early accounts of the country.

The present paper is the result of eight years somewhat intensive study of this species in Ontario, Quebec, New Brunswick and Prince Edward Island, covering the typical form (*hudsonicus*) and geographical races *loquax* and *gymnicus*, and an attempt is made to bring together the facts concerning the life-history, habits, food, relationships to other animals, economic importance, and psychology of this species which are to be found in the literature. Some details concerning the daily life of the red squirrel, and many points in connection with the psychology of this species which I have accumulated, are due to the fact that I had one individual under almost constant observation for months at a time for a period of two years and another for a year. These squirrels made their headquarters in a large sugar maple which stands in my garden, the lower branches of which are on a level with my upstairs balcony and the upper branches on a level with the window of

[1] Contribution from the Zoological Laboratory, Cornell University.

my top flat. During these periods other red squirrels came into this tree more or less frequently, so that an opportunity was afforded to obtain data on the relations of one individual to others of its species.

## ALBINISM AND MELANISM

Neither albinism nor melanism is common in this species. Bell (1898) says, "Melanism and albinism, or any variation whatever, is extremely rare. I obtained a specimen at Athabaska Lake which is pure white beneath, from nose to tail, the second half of which is also perfectly white." Adams (1873) writes: "On the reliable authority of Mr. Boardman I learn that there is a district on the south coast of the province [New Brunswick] where all the squirrels belonging to this species are black." Quoting a letter from Mr. Savage, Miller (1900) says, "Mr. John Bergtold of Bowmansville, Erie Co., N. Y. captured an adult and three young, all of which he kept alive. The adult and two of the young were perfect albinos, the other young was normal in color." Prof. J. N. Gowanloch, of Dalhousie University, informs me that he came across a case of partial, or "pie-bald," albinism in this species. Seton (1909) reports a pair of albinos on the authority of Paul Doherty.

## HABITATS

The red squirrel is at home throughout its range wherever there are trees. The spruce forest, the pine forest, the maple-beech woods and the mixed forest were its original habitats, but it now occurs in agricultural districts where the trees are reduced to farm wood-lots, groves, orchards, and groups of shade trees, as well as in parks and in cities, towns and villages where shade trees are numerous.

## HOME RANGE

It is not an easy matter to determine the exact home range of any animal, but from my observations in the case of individuals which had some diagnostic characteristic I should say that the home range of the red squirrel is usually small, about two hundred and fifty yards square. Seton (1909) puts the home range of this species at less than ten acres, and says, "Many a one passes its whole life in an orchard of from four to five acres." Seton quotes Paul Doherty to the effect that a pair of albinos were always to be found within eighty feet of their nesting-tree. Richardson (1829) would imply that the home

range of this species is extremely restricted, as he says "It does not appear to quit the tree beneath which it burrows by choice, unless when it makes an excursion in spring in search of a mate." This is, however, certainly erroneous.

There is not any question but that, under unusual circumstances such as scarcity of food, the red squirrel makes excursions some distance outside what may normally be regarded as its home range.

That a restricted home range is decidedly advantageous is readily seen, as within this area the squirrel knows every tree and limb, every jump from one tree to another, and every hole, either in a tree or in the ground, so that its chances of escape when pursued by an enemy are much enhanced.

## ABUNDANCE

The abundance of this species varies, not only from place to place, but apparently also from one season to another. In the original pine forests of Ontario, at the time the first cutting operations were going on, I should place the abundance of the red squirrel at not more than one to every twenty acres, and in the original maple-beech woods about the same. In the spruce woods of New Brunswick there are, as nearly as I can ascertain, about two squirrels to every hundred yards square. At Grand Bend, Ontario, on the shore of Lake Huron, in a piece of country with a mixed forest consisting of pine, hemlock, cedar, oak (red and white), beech, maple, butternut and hickory, I found more red squirrels in the spring of 1923 than I have seen at any other place, and a census showed nine squirrels to the acre. Merriam (1884) says, "In seasons when mast is plentiful there seems to be a squirrel for every tree, bush, stump and log in the entire Wilderness, besides a number left over to fill possible vacancies. When, on the other hand, the nut crop has been a failure, a corresponding diminution in the numbers of Squirrels is observable, and they are sometimes actually scarce." The superabundance just quoted must certainly be a most unusual circumstance. The greatest local abundance which I have seen was seventeen red squirrels in a group of five butternut trees in early September in a region in which these trees were scarce, and neither before nor since have I seen anything like such numbers gathered together.

Dice and Sherman (1922) report the numbers found in different habitats in Michigan as follows: black ash swamp, 1; cedar swamp, 3; black spruce-tamarack bog, 2; hemlock forest, 1; white pine forest, 1;

wet hardwood forest, 9; dry hardwood forest, 7; shrub stage of hardwood forest, 1; paper birch-aspen woods, 3; early hardwood stage of forest, 1.

### MIGRATION

The red squirrel is certainly non-migratory except under very unusual circumstances. Such circumstances seem to prevail in the Adirondacks as Merriam (1884) says: "James Higby tells me that in June, 1877, he saw as many as fifty crossing Big Moose Lake, and that they were all headed the same way—to the north. I am informed by Dr. A. K. Fisher that at the southern end of Lake George, in early autumn, it is sometimes an every-day occurrence to see Red Squirrels swimming across the lake, from west to east—never in the opposite direction. The chestnut grows abundantly on the eastern side of the lake, but is comparatively scarce on the western, and these extensive migrations always take place in years when the yield of chestnuts is large;" and again, quoting Winslow C. Watson, "The autumn of 1851 afforded one of these periodical invasions of Essex county."

### MATING

In Ontario red squirrels mate in March and at this time there is more chasing about among the branches than at any other time. Seton (1909) says that in Manitoba they mate late in March or early in April. Nelson (1918) notes that the males fight in the spring and sometimes inflict serious injuries on one another.

Whether they pair for life or even for a single season is a doubtful point. Seton has seen two adults at work building a nest, and notes that the two albino squirrels mentioned above were seen together all summer and winter. Certainly neither the male which I had under observation for two years, nor the female which I observed for over a year, had a mate associated with it, though the latter brought one young to the tree with her during late June and early July.

### NESTING

The nests of the red squirrel are of two kinds: nests made in holes in trees or stubs, and the large outside nests made of leaves and other materials. Both kinds serve as winter homes, but the young are usually born in a cavity in a tree, frequently in one excavated by the flicker.

In the far north where the timber is small the outside nests are used

almost exclusively. Osgood (1900) says of the red squirrel of the Yukon, "Its globular nests of grass, moss, bark and refuse are common and are usually found situated near the trunk of some slender spruce, ten or twenty feet from the ground. Sometimes several will be found in the same tree, and half a dozen or more are very often to be seen at the same time."

Cram (1901) says of these outside nests:

> When convenient, he chooses the nest of some large bird for a foundation, and in this builds a structure of moss, bark, pine-needles, and dead leaves, with walls several inches in thickness, and a soft nest of dry grass and feathers inside. The bark used is of two sorts, the rough outer bark of different trees, broken into small pieces, and what appears to be the inner bark of the red cedar, torn into narrow strips, or ribbons to bind the whole together. The narrow opening at one side is provided with a hanging curtain of moss or some similar substance, easily pushed aside by the inmates, but immediately falling back into place and effectually concealing the entrance. If unable to find a bird's nest situated to their taste, the squirrels arrange a loose platform or framework of twigs in a convenient crotch and build their nest on that.

Some of the nests which I have examined in Ontario and New Brunswick were very compactly and firmly built, while others were somewhat loosely put together.

### YOUNG

In Ontario, New Brunswick, and Manitoba the young are usually born early in May, but many broods are considerably later. I have on several occasions seen young squirrels but little more than half-grown in September and October, and at Lake Missanag on September 6 I saw an adult and five half-grown young on the trunk of a large dead hemlock, in which, at a height of about twenty-five feet, was their nesting-hole. These late occurrences of young may possibly indicate a second brood, though, if this is the case, it is certainly the exception and not the rule.

Speaking of *S. hudsonicus richardsoni*, Bailey (1918) says:

> In June the four to six young are born in the big grass nests up among the branches of the trees or in well-lined hollow trunks. For a long time they are naked and helpless, and apparently they do not usually come out of the nests as half-grown squirrels until the latter part of July. They are carefully watched and nursed and fed by the mother squirrel until they have learned the ways of the woods, and by the latter part of August have scattered out, each storing his own winter supplies or all working and storing together as a family for the winter's supply about the old parental tree. Usually the families do not entirely break up until the following spring.

Seton (1909) says:

A home nest which I found at Carberry, Manitoba, June 24th, 1882, was twenty feet up in an abandoned Flicker's hole in a poplar stub. It contained five young. They were blind, naked and helpless, and had no sign of aural orifice. They measured about 4½ inches long, including the tail, which was 1½ inches. While I was up the stub the mother dashed up and down the far side, running over my hands and arms, in her distress for their safety, quite reckless for herself. I put the young back, intending to come again and watch their development. But the mother had other plans for them. She removed them at once, and I did not discover their new abode.

And, again, speaking of a female which raised her brood for several years in a box set in a thin hemlock near his house, "In June I often see the little ones following the old one in a sort of procession through the trees. This is no doubt their training."

Cram (1901) thus describes the young:

The young squirrels are most absurd looking little beasts at first, like miniature pug dogs, blind and naked, and with enormous heads. In a few days their fur begins to show like the down on a peach, and as a fringe of short hair along each side of the tail, which at length assumes something of the flattened aspect of that worn by their elders, but without displaying much of the quality of the fluffy, shadowy quality of the ideal squirrel tail until late in the following autumn. Although they do not remain long in the nest, they are seldom seen abroad until fully grown, or very nearly so, which is rather remarkable when you come to consider the number that are brought up each summer in every pine grove or thicket where these squirrels are abundant. Occasionally you may see a family of them playing timidly about among the branches, but without displaying any of the self-confident recklessness of their elders, quick to take alarm at the slightest hint of danger and scurry back into concealment.

I have seen two squirrels about two-thirds grown following an adult in early October in Ontario, but they had passed the stage of timidity mentioned above; figure 3 is a photograph of one of them, which shows curiosity personified. In July in New Brunswick I have seen an adult and four young feeding together in the tamaracks.

## LENGTH OF LIFE

There are, as far as I know, no data on the length of life of the red squirrel in the wild condition, but Charles Macnamara informs me that one which he caught when a few months old, and had in captivity, lived for nine years. The account of this squirrel, as given by Mr. Macnamara follows:

When I was a young fellow, while walking along a woodland path with some friends one day about the middle of May, we noticed a small red squirrel with a

rather large head, playing on an upturned root. As we came closer to look at him, he sprang to the ground and, apparently taking me for part of the scenery, ran up my leg and under my coat to my shoulder. When I caught him in my hands he did not seem much afraid and made no attempt to bite; and I carried him home wrapped up in a handkerchief in my pocket.

When the squirrel was offered food, it was seen that he was too young for anything but milk, and so he was fed for some weeks—I do not now remember just how long—by dipping a shred of sponge into milk and giving it to him to suck. Presently he began to lap from a saucer and to eat a little milk-soaked bread. Next he began to nibble at nut kernels, and finally towards the end of the summer he could gnaw open walnuts and filberts for himself. This all happened some 25 years ago and I can not recall exact dates, but my recollection is that at what I judge to be four or five, perhaps six, months of age, he was eating adult squirrel food.

For about a year he was quite tame and harmless, and was permitted to run about the house a good deal. But he began to bite people occasionally without the slightest provocation—just for the fun of the thing; and loving to explore cupboards and drawers, if the opening was not wide enough to let him in, he would try to enlarge it with his teeth. One day he was caught eating his way into an expensive bureau, and an incensed household demanded his confinement.

The tea chest that had heretofore been his home was replaced with a box three feet long by two feet deep and high, with a wire-netting front and netted windows at either end. A little box, eight inches by four inches by four inches with a small arched door in the end, nailed in one of the upper corners served as a sleeping place. This cage was kept on a verandah all summer, and was moved into a hallway in winter. He was a very cleanly little creature, and I never noticed the slightest smell from him. He always frequented one particular corner of his cage in answer to nature's calls, and, by my putting a little dry earth there, renewed every few days, and keeping the floor covered with fresh sawdust, his cage was always fresh and clean.

These were narrow enough quarters for such an active animal as a squirrel, but a system of exercise he invented kept him in good condition during what was probably a long life for a squirrel. A "daily dozen" was not nearly enough for him; he took a daily thousand. Dashing across the floor of his cage, he flew up the wire netting front, and flung himself, back downwards, across the ceiling, and then down the back of the cage and across the floor and up the netting again, going round and round so rapidly that he appeared not more than a streak. He would keep this up for five or ten minutes at frequent intervals all day, and his steady thump, thump, thump, became a familiar sound around our house. He had a habit of bringing out a large mass of the cotton-waste of his bed and carrying it in his mouth while he was going through these gyrations.

He seemed to know me better than anyone else, and I grew very fond of him. One day, coming home at dark from an outing, I was told the sad news that he was missing. Somehow he had scratched open the back door of his box, and he had last been seen dashing through the raspberry bushes in the garden, with our big tom cat close behind him.

I went to bed with a heavy heart and got up before sunrise to look for his remains. It did not seem possible that he could have escaped, and I did not ex-

pect to find more than his tail. The dew on the shrubs in the garden soaked me, out I found no trace of the squirrel. I wandered disconsolately out of the garden and across the yard, and was standing aimlessly in an open shed when I heard a slight noise overhead. There was my squirrel on a beam above me, and when I held up my hand to him, he came down a post with the usual red squirrel hesitations, and leaped onto my arm. The call of the wild was not for him. He preferred his safe comfortable cage where there were plenty of Grenoble walnuts and no fierce cats.

One winter all the hair came off his back from neck to tail, exposing his livid blue skin. I rubbed a little vaseline on him, but hesitated to apply any remedy, as like all animals, and some primitive peoples, his sole idea of therapeutics was to lick the place, and I was afraid of poisoning him. But after some months the hair grew in again as thick and healthy as ever. His usually excellent coat was a little darker than that of the average wild squirrel. He was fed principally on filberts, almonds and walnuts, and his pampered appetite showed little interest in the local hickory and beech nuts or acorns. The only wild food he really seemed to like was pine cones. He got quite excited when he caught sight of them and seemed greatly to enjoy tearing them to pieces.

The ancestral habit of his race to lay in a stock of food for the winter was very strong in him. Although he was never hungry for five minutes in his life, he acted as if a dire famine was threatening. The nuts given him every day were always rather more than he needed, and he carefully stored the surplus in his sleeping compartment, gradually accumulating such a hoard that there was scarcely room enough left for him to get in himself, and he had to sleep with his tail hanging out. I used then to shut him out of the compartment and remove the nuts by a back door. This always caused a great fuss. He was being robbed of his hard-won store, and he would surely starve to death next winter! He chattered and scolded, and scratched frantically at the slide that shut him out of his bedroom, and dashed around the cage in great excitement. He did not quiet down until he was let into the compartment again and given a few nuts to start a new hoard.

He never made any determined attempt to gnaw his way out of the cage—which was made of half inch ash, and would not have been hard to eat through—, except in his sleeping chamber, where I eventually had to fit a piece of tin to stop him. His idea was probably to enlarge the chamber and not to escape. His teeth were always in good condition, but his claws used to grow long and curve inwards, so that I had to cut them every few months.

Up to his fifth or sixth year his activity was as great as ever. Then he began to show signs of age. In his youth he used to leap straight into the door of his bedroom; later I set a branch diagonally from a lower corner of the cage up to the door, and for a long time he could climb this nimbly enough. As his infirmities increased he gave up his circling exercise and at last I had to replace the branch with a flat board with grooves cut across it, up which he used to hobble to bed.

The direct cause of his death I think was lead poisoning contracted from some freshly painted furniture which was placed near his cage to dry. He may have reached out and licked the paint, or perhaps the fumes were enough to kill him in his decrepitude. As well as I can remember, he was in his ninth year when he died.

## PERIODS OF ACTIVITY

The red squirrel in Ontario is active at all seasons, except for periods of a day or two at a time in extremely stormy, cold weather in the winter. Merriam says of it in the Adirondacks: "He remains active throughout the continuance of excessive cold. When fierce storms sweep over the land he retires to his nest, to appear again with the first lull of the wind, be the temperature never so low." Dice (1921), however, reports that in Alaska "When the temperature drops below −30°F. very few squirrels are active and they become dormant at lower temperatures."

The red squirrel's daily period of activity in summer is usually from sunrise until twilight. I have found that very few are about earlier than sunrise, and I have never seen one abroad after dark. Others, however, report that these squirrels are sometimes active at night. Merriam (1884) says "He may sometimes be discovered in the darkest hours of the night, stealing softly over the ground—bent, doubtless, on some errand of dubious propriety. Moonlight evenings he is often active, though not so noisy as during the day, and in early autumn vies with the flying squirrel in nocturnal nut-husking exploits." Nelson (1918) states that it "sometimes continues its activities during moonlight nights, especially when nuts are ripe and it is time to gather winter stores." Judging by the two squirrels I have had under constant observation, this species is not an early riser in the winter, as neither of them put in an appearance at their tree, around which much food was stored, until well after daylight.

## RESTING

The red squirrel is usually spoken of as being "constantly active," but this is not absolutely correct, as both individuals which I have observed closely rested for a time each day in spring, summer and autumn, the period of rest, and sometimes of sleep, being usually between one-thirty and three o'clock. I have seen other squirrels in various parts of the country thus resting in the early afternoon, and the squirrel's reputation for "constant activity" is probably based on the fact that they are readily seen when they are active, and have not been noticed when they are not.

The resting attitudes are various, but there are two chief ones. In one of these the animal spreads itself out on a limb, with the tail lying out behind (fig. 5) and the chin resting on the limb; in the other, the

squirrel squats down, rests the chin on the limb and folds the tail close over its back (fig. 6). Variants of these positions are that the tail may be folded down over the back in the first position and that it may be stretched out behind, or hanging to one side, in the second. A less usual resting position, the animal fitted into a fork with the front of the head resting on the limb, is shown in figure 7. Sometimes, but as far as I have observed very rarely, the squirrel may go sound asleep in any of these positions. As a rule it closes its eyes only for a few minutes at a time, but on the other hand it may remain for half an hour or more without opening the eyes widely.

After resting the squirrel almost invariably stretches, first one hind leg and then the other, and yawns widely, curling the tongue upwards like a dog.

### SUNNING

In the winter and early spring the red squirrel often selects a more or less sheltered spot and basks in the sun, sometimes for an hour or more at a stretch.

### ACTIVITY IN THE TREES

The agility of the red squirrel on the trunk, limbs, and the finest twigs of the trees is remarkable. Sometimes it bounces about among the branches like an animated rubber ball, moving at such a rate that it becomes a mere blur. It travels about in the trees at such a speed, in such an apparently reckless manner, and in places where its hold seems so precarious, that the wonder is not that it falls occasionally, as it does, but that it does not fall a dozen times a day. I have seen a squirrel sitting apparently entirely unconcerned on one of the topmost twigs of a seventy-foot elm, when a stiff wind was swaying the upper branches through an arc of about four feet, eating an elm bud held up in its fore paws. It travels with ease on the underside of limbs, both large and small.

### LEAPING

The red squirrel makes long leaps from tree to tree, but these are always made when the landing place is lower than the point from which it takes off. A jump which one of the squirrels I had under constant observation made many times a day was a distance of eight feet with a drop of two feet, and I noticed that it never tried the return leap. The most remarkable leap I have seen a squirrel make was a

distance of five feet with a rise of three feet. Seton says that after measuring many bounds recorded in the snow, and made by squirrels pursued by dogs or hunters, he does not think that they can leap more than five feet on the level. In these cases the soft snow probably impairs the efficiency of their "take-off."

In leaping the squirrel extends its legs and flattens its body, while the tail is straight and stiff behind it. In most cases the leap is very cleanly made, but sometimes, in cases where the object from which it has jumped is insecure or springy, or when the squirrel leaps with a bulky load, its leap is not so well controlled, and it makes desperate efforts by movements of the tail and legs to maintain its direction while in the air. In such cases it often makes anything but a graceful landing.

### FALLING

The red squirrel very rarely falls, but occasionally does so. I have never actually seen one fall, though I have witnessed their having very narrow escapes from accidents upon many occasions. I once came across a young squirrel, which had apparently fallen from a high limb of an elm onto a cement sidewalk. It was squatting on the walk, looking very dazed, and rubbed its head with its fore paws repeatedly. Mrs. Klugh has seen a squirrel fall from a branch of the tree in our garden on two occasions. In both cases the squirrel was an intruder and was being vigorously pursued by the squirrel which "owned" the tree. In neither case did the squirrel alight on its feet, but in one case came down so heavily on its side as to apparently "knock the wind out of it" and it was some minutes before it recovered sufficiently to crawl to the tree and climb up; and in the other case the squirrel fell on its back on a sheet of ice and appeared to be badly shaken. The fall in each of these cases was a distance of about thirty feet.

Gosse (1840) describes how a squirrel in a grove of tall slender trees was chased from tree to tree for half an hour by shaking the trees violently. "He several times missed his hold, but always caught a bough in his fall, except once, when he came rather heavily to the ground from one of the topmost branches; he was instantly on his feet again and up in a tree before I could come near him."

Cram (1901) says:

> On still winter days you may see them springing about among the elastic branches (of the hemlock), clinging to the very tips of the finely divided sprays at a perilous height in their endeavours to reach the cones that are hung on such

exasperatingly slender twigs, hardly large enough even for a squirrel's foot to grasp; and not infrequently a misstep will send one of them headlong down towards the earth, usually to save himself by catching hold of one branch or another on the way down. If there should chance to be no branches beneath him, he spreads himself out, like a flying squirrel, to a remarkable degree of flatness and strikes so lightly as to escape all injury, even on hard snow crust or ice.

That the tail acts not only as a rudder in leaping, but to a certain extent as a parachute in the case of a fall, is probably true. Seton (1909) says that the loss of the tail "is a serious handicap, as is proved by the fact that a tailless squirrel rarely survives. The loss seems to limit its jumping power, and when it falls it suffers a heavy jar, from which the tail would have saved it;" and speaking of a squirrel which had its tail stripped off by a trout: "The animal was not obviously crippled, and yet, as usual, the tailless one disappeared." He also mentions a red squirrel which was found dead under a tree by Francis Dickie in Manitoba. "The tail was gone, except half an inch of stub, which looked as if it had been chewed off."

### ACTIVITY ON THE GROUND

Though decidedly an arboreal species the red squirrel is quite at home on the ground. Except under very unusual circumstances it rarely gets very far out into the open, and its usual route in travelling over the ground is from near the base of one tree to the proximity of the base of another, the intervening space, if of any considerable extent, usually being covered in a succession of long, rapid bounds. Its activities on the ground are usually connected with food or drink, or to get from one group of trees to another. Some of its storehouses are holes in the ground, usually beneath a tree or stump, and it buries nuts here and there in the soil.

### TUNNELLING IN SNOW

In winter the red squirrel makes extensive tunnels under the snow. These tunnels are made sometimes to connect one storehouse with another, sometimes to get at food material which is lying on the ground. One year, when my sugar maple had produced a very large crop of keys, the squirrel constructed a system of interconnecting tunnels with several entrances and exits to reach this food supply. Cram (1901) says, "Often, instead of burrowing down repeatedly to each little pile of cones, they dig radiating tunnels along the surface of the ground, from the first one opened to the others near it, dragging the cones

laboriously along their winding galleries to the surface and away over the snow to some favorite stump before attempting to open them." In digging these tunnels the squirrel does not bring any snow to the surface, but packs it against the walls, and makes a shaft to the surface either at the end of a tunnel, or where two tunnels connect.

### SWIMMING

That red squirrels swim well has already been shown in the section on migration, as Big Moose Lake, which they are reported as swimming across, is about a mile and a half wide, and Lake George, at the point they crossed, about two miles wide. Cole (1922) saw a red squirrel swim to shore after having crossed White Sand Lake, Wisconsin, and was told by a boatman that they had been doing this for some days past. "The individual we saw swam calmly and evenly with the head well up, shoulders nearly submerged, but rump and tail high. It did not seem at all fatigued when it reached the land."

A very peculiar incident is thus described, in a letter to me, by Allan Brooks:

> I was walking along a big mining ditch about nine feet wide in which the water was running swiftly when I saw a curious animal coming down the bank on the other side. Presently I saw it was a red squirrel staggering under the load of a two-thirds grown young one wrapped round its neck just back of the head. It came straight for the water and swam across, landing in front of me, and climbed the bank to my feet. Here it first caught sight of me, threw off the young one, jumped into the water, swam over, ran up the bank and into the woods. The young one ran up me, stopped on my chest just below my chin for a second or two, then ran down into the water, swam across, ran up the bank and off into the woods after its mother.

### MANUAL DEXTERITY

Though the squirrel lacks a "thumb" its dexterity with its fore paws is much greater than in the case of most mammals. By taking them between its paws, it handles both large and small objects with precision and certainty. It can turn a smooth and slippery nut round and round in its paws, and only very rarely does it let anything drop.

I have on three occasions seen a squirrel reach out and pull off a bud with a single paw, in doing so folding the toes against the palm. I have also seen a squirrel pick rose hips with one paw and convey them to its mouth as shown in figure 8.

### BALANCING OF OBJECTS

The red squirrel is an expert in balancing objects on branches. Usually it selects either a crotch, or the somewhat flat surface at the point at which a horizontal branch comes off from a limb, as the place of deposition. When placing anything in position it shifts it a trifle to one side or the other with its paws or its muzzle, and does not leave the object until it is as securely lodged as possible. I noticed that when one of the squirrels I had under observation hung a long strip of ham rind (an article of diet with which it could hardly have had previous experience) on a branch, it shifted it until the two ends hung equally on each side of the branch.

### PLAY

Adult squirrels frequently play together, their recreation taking the form of a game of "tag" in which the utmost vivacity and agility is displayed. A good deal of what is commonly reported as a game of tag is, however, really not play but the chasing of one squirrel by another when the former has been poaching on its preserves, and it is only when the same squirrel is alternately pursuer and pursued that one can be sure that it is really a game.

The squirrel which I had under observation for two years, and which was at least three years old towards the end of the period of observation, frequently indulged in play by itself. When the first snowfall came it plunged about in the snow, dashed through the deep piles on the large limbs, and quite evidently enjoyed itself thoroughly. It frequently went through a remarkable performance which one must classify as a game since it certainly served no useful purpose. At the top of the trunk of the maple, at the point at which the main limbs are given off, there is a trough-shaped, vertical cavity some eighteen inches long with a pocket-shaped bottom. The squirrel often got in this cavity, turned over and over in a series of somersalts, sliding down the trough on its back at each backward turn. It sometimes also seized and held onto its tail and rolled about in the pocket.

### DIET

The diet of the red squirrel is extremely varied, and naturally differs considerably in various parts of the country. One reason for the wide range and abundance of this species, and for its ability to inhabit a region under the changed conditions produced by civilization, is unquestionably its omnivorous propensity.

The two staple articles of diet of the red squirrel, taking the whole of its range into consideration, are undoubtedly the seeds of coniferous trees, and nuts. By far the greater part of the red squirrel's range lies in the Canadian and Hudsonian zones, which are vast areas of spruce and fir forests, and there are unquestionably more squirrels which feed most extensively and for a longer period each year on the seeds of these conifers than upon any other kind of food. In the typically Canadian zone country in New Brunswick this species feeds very largely on the seeds of white spruce (*Picea canadensis*) and red spruce (*P. rubra*) from the middle of August until May, and some idea of the immense quantities consumed may be obtained from the huge piles of scales to be found in the spruce forest and the large areas which are covered with these scales. Osgood (1900) speaking of Alaska, says, "The ground is often strewn for some distance with the scales of spruce cones which they have stripped. Near Lake Marsh I found one such place twenty feet square which was covered six inches deep with scales." Bell (1898) says, "The seeds of the black and white spruce constitute their grand staple in the north." The seeds of practically all the other conifers, in their respective regions, furnish the red squirrel with a large part of its sustenance. The seeds of the cedar (*Thuja occidentalis*) are eaten extensively in New Brunswick, Quebec and Ontario, and the seeds of the hemlock (*Tsuga canadensis*), which remain in the cones on the trees all winter, are eaten throughout the winter in northeastern North America. Seton (1909) states that "In the country about Kenora (northern Ontario), the principal autumn (and therefore winter and spring) food of the squirrel is the seeds of the jack-pine." The seeds of the white pine (*Pinus strobus*) are consumed extensively throughout the range of this tree, and Cram (1901) says, "The white pine is usually rather sparing in its yield; but once in every ten or fifteen years, perhaps oftener, nearly every tree in the forest bears enormously, even the younger ones showing scattered clusters here and there, while those that have stood for generations present a roughened, shaggy aspect from the thickly crowded cones at their summits. At such times the red squirrels seem determined to gather every cone before it opens and scatters its seeds to the winds." Bailey (1918) mentions the lodgepole pine, Douglas spruce, Engelmann spruce, mountain white pine, white-barked pine, western tamarack, and western balsam as furnishing the chief food-supply of *S. hudsonicus richardsoni* in the mountains of northwestern Montana.

Farther south all kinds of nuts, within their respective ranges, con-

stitute the main food of the red squirrel, since they are not only eaten at the time of their ripening, but are hoarded for consumption during the winter and spring. But nuts never bulk as largely in the menu of the southern squirrels as do the seeds of conifers in the diet of those of the north, because, firstly, there are few, if any, localities where nut-bearing trees occur in which some species of conifer does not occur and furnish part of the squirrels' food, and, secondly, nowhere do nut-bearing trees form the dense, pure stands that the spruce does in the north. Beechnuts, hickory nuts, black walnuts, butternuts, chestnuts, and hazel nuts are all eaten both fresh and stored wherever they occur. Bell (1898) says, "Northward of the zone of butternuts, and beechnuts, etc., the hazel extends a long way—say, to a line drawn from Lake St. John (on the Saguenay) to Lake Athabaska, curving southward of James and Hudson Bays—and affords a large proportion of their food."

In the mixed forests of the Alleghanian faunal area the acorns of the white, red, and burr oaks, and the keys of the sugar maple and soft maple constitute a very considerable proportion of the food of this species.

In the spring the red squirrel eats the buds of a large number of trees, both when they are swelling and when they are partially expanded. It is probable that it takes the buds of any deciduous tree, and of some conifers, such as the spruce, but the buds which I have actually seen it eat are those of the sugar maple, soft maple, elm, beech, ironwood, yellow birch, hybrid willow (*Salix alba* x *fragilis*), poplar (*P. tremuloides*), and spruce, and the staminate catkins of the tamarack and red oak. When feeding on buds of the sugar maple and elm, and on the staminate strobili of the tamarack, I have on several occasions seen squirrels hang down by their hind feet from a twig to reach buds on the tips of the twigs beneath them, usually pulling themselves up again to the branch above to eat the bud, but sometimes consuming it while hanging head downwards.

In spring and early summer the red squirrel sometimes cuts off leaves of the sugar and soft maples, eats part of the petiole, and drops the rest of the leaf.

The red squirrel eats the bark of the smaller branches of some species of deciduous trees, especially that of the sugar maple, at all seasons of the year, even in summer when green food is abundant. It is thus not by any means entirely a "starvation ration," as has been supposed, but is eaten apparently merely as a change from other articles of diet.

Seton says that in Manitoba: "The third principal food supply is the thinnest greenish outer bark of the Quaking Aspen or Poplar. This it does not store up, but gathers as it is needed in time of famine" and Burroughs (1900) says "But the squirrels of this locality evidently got pretty hard up before spring, for they developed a new source of food-supply. A young, bushy-topped maple, about 40 feet high, standing beside a stone fence near the woods was attacked and more than half denuded of its bark. The object of the squirrels seemed to be to get at the cambium layer. The ground was covered with fragments of bark, and white, naked stems and branches had been scraped by fine teeth."

The red squirrel is not a markedly frugivorous species, but occasionally it eats some fruits of various kinds. I have seen it eat the fruits of the wild gooseberry (*Ribes cynosbati*), black elderberry (*Sambucus canadensis*), red elderberry (*S. racemosa*), raspberry (*Rubus strigosus*), bunchberry (*Cornus canadensis*), wild strawberry (*Fragaria virginiana*) and wild rose (*Rosa lucida*), but only on rare occasions. It takes apples more frequently than any other kind of fruit, especially those that are left hanging on the trees all winter, usually biting off and throwing away the skin and pulp and eating the seeds, but sometimes eating some of the pulp. The only case of depredations on cultivated fruits which has come to my attention was reported to me by Dr. A. H. Leim, who told me that at Fergus, Ontario, he has seen this species take strawberries before they were ripe, eating the green side and leaving the riper side; next green gooseberries, carrying them off; then white and red currents, which they ate; then green apples, about one-half grown, which they both ate and carried off.

The red squirrel is very partial to mushrooms of many species, both eating them in the fresh condition and storing them in large quantities. I have seen squirrels eating *Pleurotus ostreatus*, *Collybia radiacata*, *Canthrarellus cibarius*, *Russula* of many species, *Boletus* of several species, *Lepiota naucinoides*, *Morchella esculenta*, *M. conica* and *Clavaria aurea*. Whether the red squirrel eats the poisonous species, such as *Amanita muscaria* and *A. phalloides*, and whether, having done so, disastrous consequences ensue, is a point upon which there are no exact data. I have in several cases noticed large numbers of very fine specimens of *Amanita muscaria* entirely untouched in habitats in which red squirrels were common. On the other hand, one day I saw a squirrel sitting on a fence eating a piece of mushroom which looked much like a piece of *A. muscaria*. When I went close the squirrel dropped the

piece of mushroom, and nearby I found a specimen of *A. muscaria* with a piece of very similar size taken out of it. This is at best only circumstantial evidence, and the sequel remains entirely unknown.

Roots of some woodland plants and underground stems are apparently eaten to some extent by the red squirrel. I have seen them digging for something in the spruce forests of New Brunswick, but whether for roots or insect larvae or pupae I could never determine. Osgood (1900) says that in the Yukon "little excavations in the moss show where the Chickarees have been digging for roots."

A peculiar food-habit of the red squirrel was reported to me by Dr. A. H. Leim. In July he saw the squirrels eating the seeds from the heads of timothy (*Phleum pratense*) and orchard grass (*Dactylis glomerata*) which they could reach from the posts of a fence. Having obtained all those which they could reach from the posts, they started out along the three-strand barbed wires, and from there they got those that they could reach with their mouth or with their front paws. One squirrel, apparently a young one, went out along a wire, swung down, retaining a hold on the wire with its hind feet, caught a head with its front paws, pulled it back, bit it off, and then either raised itself to the wire from which it was suspended or dropped to the wire below. He also observed them jumping from the ground, catching a timothy head, and bearing it to the ground. One squirrel would persist in this occupation for half a day at a time.

The red squirrel at times takes animal food, the kinds most frequently eaten being insect larvae, young birds and bird's eggs. I have seen them eat the larvae and sometimes the pupae of several kinds of insects. Cram (1901) says, "Occasionally you will see one clinging to the side of some dead pine or hemlock, and listening, woodpecker-like, to the sounds made by the insects at work beneath the surface. When he has succeeded in locating his prey, he tears off the loose bark with his teeth in great ragged pieces, and presently pounces upon and drags forth a flattened white grub an inch or more in length, which he devours with great apparent relish."

That this species eats the eggs and young of various species of birds is shown by many data presented in ornithological literature, and this will be referred to later. Personally, I have never yet seen a red squirrel take either an egg or a young bird, and certainly these items constitute an insignificant portion of the food of the average red squirrel.

## STORAGE OF FOOD

The red squirrel stores immense quantities of food, chiefly the seeds of conifers, nuts, and mushrooms. During late summer and autumn the chief activity of this species is the storage of food. It also stores food temporarily at all seasons of the year.

This species practices three methods of storage: carrying things off to one of its main hoards, burying each object separately, and arranging them in a fork of a tree. Food materials are pretty definitely classified into two categories: hard objects and soft. Hard things, such as nuts and seeds, it either carries to one of its storehouses or buries; soft things, such as fungi, fruits or pieces of meat, it arranges about the branches of a tree. Thus it does not bury or put in piles anything which will mold or decay readily.

The squirrel's main hoards are made either in cavities in trees or stubs, or in vaults underground, beneath the roots of a tree or a stump, or under a boulder. It has several such storage places, and, as far as I have observed, when a squirrel is storing a number of things consecutively it takes them to two, or more, of these hoards alternately.

In the case of both cones and nuts the squirrel cuts them from the trees just before they are fully ripe. This is necessary in the case of most cones (the main exception being those of the hemlock) as the seeds are shed as soon as fully mature, but the same necessity does not exist in the case of nuts. But as Seton says in speaking of the cutting-down of chestnuts before they are fully ripe: "The explanation lies in the fact that the Red Squirrel has been evolved to prey on the seeds of conifers. If these are left to ripen fully they take unto themselves wings and fly away, whereas by cutting the cone just before it opens the Squirrel makes sure of the prize."

Bell (1898) says, in connection with the harvesting of the cones of the white spruce in the north:

> Their mode of obtaining a supply of cones is ingenious. The cones grow principally at the tops of the spruce trees, and the largest and finest are always to be found there. The Chickaree selects a tree which, either because of the steepness and density of its upper parts, or because of its leaning to one side, makes it certain that the cones, if detached, will fall to the ground; then he cuts off the heavily-laden branches and lets them drop. This is done with an impatient rapidity. These branches seldom lodge in the branches below, but should a squirrel on his way down notice one of them in a hopeful position towards the extremity of a bough, he will sometimes run out and give it a second send-off.

Professor J. N. Gowanloch informs me that at Gimli, Manitoba, the red squirrels in August cut the green cones of the balsam (*A. balsamea*). A single squirrel to a tree would spend three hours or more cutting off cones and then in the afternoon would carry off the cones and deposit them in holes under the roots of trees.

Speaking of squirrels harvesting the cones of the white pine Cram (1901) says:

> They begin work late in July, while the cones are still green and solid with the seeds embedded near the centre. In the hot July sunshine they hurry at their work, cutting off the cones and tossing them over their shoulders well out beyond the surrounding branches to the ground. Whenever the cone of the twig that supports it is cut or scarred, a drop of glistening, transparent sap oozes forth, turning on exposure to the air to the most tenacious kind of pitch; and it is truly wonderful that the squirrels can manage to keep themselves so clean while engaged in their harvesting. But the majority of them show hardly a trace of pitch, though now and then you will run across one with little whisps of fur stuck together, especially about the face and neck and in the longer hairs of his tail, evidently having been particularly unfortunate or careless in his work. Every little while they descend to the ground to bury the cones they have cut off, two or three in a place, covered with pine needles to a depth of several inches.

Audubon and Bachman (1846) say: "The quantity of nuts and seeds it often lays up in its store-houses is almost incredible. On one occasion we were present when a bushel and a half of shell-barks (*Carya alba*) and chestnuts were taken from a hollow tree occupied by a single pair of these industrious creatures."

Paulmier (1903), referring to this species in the Adirondacks, says: "Later still, when the beechnuts, which form his staple food, are ripe, he collects immense quantities of them, biting off the yet green nuts, so that they fall to the ground, where he afterwards collects them in heaps and stores them away."

Hahn (1909), speaking of *S. h. loquax* in Indiana, says: "Much of its time is spent on the ground where it gathers acorns and nuts and buries them under leaves and under the soil. Some supplies are stored in hollow trees also, although snow is no hindrance to its finding and securing buried treasure."

Bailey (1918) thus refers to the harvesting of the cones of several species of evergreens in the mountains of Montana:

> Before the seeds are fully matured in the cones they begin to serve as food for the squirrels, and when well ripened the cones are cut from the pine, spruce, and fir trees in such numbers that the woods often resound with their steady thumping on ground and logs. During autumn great numbers of cones are cut off and stored

in little pockets or holes in the ground, under logs, rocks, or brush-heaps, or in the piles of old cone scales at the base of the feeding trees, where they can be readily found under the deep snows of winter.

Two friends of mine one evening found a red squirrel's hoard of butternuts in a hollow tree in northern Frontenac county, Ontario, and filled a bushel-and-a-half bag with the nuts from this single hoard. They left the nuts in the bag some yards from the tree, and returned with a wheelbarrow the next morning to fetch them. But the squirrel had been there before them, chewed a hole in the sack, and removed every nut to some other storehouse, which they were unable to locate.

The red squirrel buries single nuts and acorns here and there in the soil. When it buries a nut it scratches out a hollow with its fore paws, places the nut therein, shoves it in as far as possible with its nose, and then covers it with a few swift strokes from right and left with its fore paws. It performs this operation with great rapidity, but does it so well that when it has buried a nut in a location where there is moss and dead leaves there is no trace of any disturbance. In fact upon several occasions I have noted as nearly as possible the exact spot at which I had seen a nut buried, but upon going to the place I was unable to find the nut.

Nuts are sometimes stored singly in the crotches of trees, or wedged under a flange of bark of rough-barked trees. Gibson (1903) has noted this habit, and says, "The shell-bark hickory is the squirrel's favorite storehouse. A quick stroke with axe or sledge will often dislodge numbers of nuts which have been packed away and wedged beneath the bark by these provident little fellows."

Mushrooms are stored in large numbers by squirrels, which hang them in the forks of trees, and I have seen trees which contained as many as twenty mushrooms thus suspended. Dice (1921) reports an unusual case of mushroom storage: "A red squirrel in 1911 had its nest on a shelf in an old cabin north of Tanana (Alaska). This squirrel had collected a great number of mushrooms and stored them on the shelves. Those not entirely dry were spread out separately from the others. Every open can in the cabin was packed tightly with the dried fungi."

Any article of food may be temporarily stored in a crotch of a tree, quite frequently something which the squirrel has partially eaten, and it will return a few minutes, a few hours, or some days later, take it out, and either finish it, or eat more of it and store it again, usually in another place.

The squirrel's highly developed hoarding instinct sometimes renders it a nuisance about the habitations of man. It sometimes makes repeated visits to corn-cribs and carries off considerable quantities of corn, and I have known a squirrel to carry off most of the grains in a small sack of wheat. Gilpin (1870) says, "The winter camps of the loggers become infested with them. The men scarce left their camps for their work than the silent structure is attacked by an army of invaders; every hole, every crack and orifice is pryed into, an entrance is made, and perhaps half a barrel of hard bread has been removed by these pilferers before the men return for the night."

### CARRYING CAPACITY

The red squirrel can carry off objects of considerable size and weight. One morning the squirrel that I had under observation entered the pantry through the open window. There it discovered a dish of boiled potatoes, some of which it hid behind cans on the pantry shelves, while it carried the others up the maple and arranged them in crotches. Some of the potatoes which it carried up the tree weighed a quarter of a pound. The heavily laden branches of the cedar which the squirrel cuts from the tree are bulky and quite heavy, and the characteristic method of carrying such an object, the head being held high, is shown in figure 9.

### DRINKING

I have only on two occasions seen a squirrel in the woods drink, once from a pool in a little stream and once at the edge of a temporary woodland pool; but the squirrels which I have had under observation frequently drank quite copiously from a saucer of water, and I have also seen them drink melted snow in the spring. This species frequently eats snow in the winter.

The favorite beverage of the red squirrel is unquestionably the sap of the sugar maple, and in early spring in the maple-beech woods, in the mixed forest, and wherever this tree occurs, they spend a large part of their time drinking sap. They obtain this sap in three ways: from that which runs down the underside of branches which have been broken off by the winds of late autumn and winter, from the holes drilled by the yellow-bellied sapsucker, and from incisions which they make for themselves. The former source of the sap flow is by far the most important, as a heavy flow of sap often proceeds from the ends of these broken branches, and in availing themselves of it the squirrels hang

on to the underside of limbs, both small and large, as shown in figure 10. In maintaining this position on the under side of large limbs they rely chiefly on their hind legs, and there is a decided outward bend in these legs at the tarsal joint which evidently enables the claws to catch the crevices of the bark more effectively. When the squirrel hangs from a small branch, both fore and hind feet are clasped about the branch, so that the toes nearly meet on top of the branch.

Stone and Cram (1902) refer to the incisions which the squirrels make for themselves: "In tapping the maple they gnaw saucer-shaped cavities in the upper side of a branch and drink the sap which fills them, coming back a dozen times a day for the sweet refreshment." I have occasionally seen squirrels thus engaged.

In drinking sap they lap it up, their tongues going at a tremendous rate. They also lick the icicles of sap which have formed during the night.

### WASHING

After eating anything sticky or greasy the squirrel licks its fore paws very thoroughly, and then rubs them repeatedly over its nose, often spending five minutes thus cleaning up.

### SCRATCHING COMBING AND RUBBING

During autumn and winter the squirrels which I have had under observation did not seem to be much troubled by external parasites, but towards spring they had a busy time with them. They scratched and bit themselves frequently, and often for some time at a stretch, causing the shedding hair of the winter coat to fly in all directions.

The red squirrel often rubs its jaw and throat along a limb, in this respect reminding one very much of the actions of a cat.

This species not infrequently combs its tail; in doing this it sits up, brings its tail forward between its hind legs and runs the hairs through its teeth.

### ENEMIES

The chief enemy of this species in the northern woods is the pine marten, whose climbing ability and agility in the trees equals that of the squirrel. Both in the north and further south, weasels and hawks and owls are the red squirrels' enemies. Fisher (1893) lists the goshawk, Cooper's hawk, red-tailed hawk, red-shouldered hawk, broad-winged hawk, and barred owl as including this species among their food.

### RELATION TO GRAY SQUIRRELS

Wherever the red and the gray (or black) squirrel inhabit the same territory the red always chases the gray and the latter runs without putting up a fight, though it is nearly twice the size of its fiery pursuer. A report which has wide currency among trappers and hunters is that the red squirrel castrates the gray. Seton says that this is "an ancient, picturesque and sanguinary myth," and I was of the same opinion until I was told by Prof. Manley Baker that he had actually seen a red squirrel seize the scrotum of a gray squirrel, and tear it open, on at least a dozen different occasions. He did not think that the act was the result of a deliberate attack for that purpose, but that the red squirrel seized and hung onto the most posterior part, aside from the tail, of the fleeing gray squirrel's anatomy. Professor Baker also stated that he had shot more than forty gray squirrels which had been castrated.

### RELATION TO BIRDS

There is plenty of data in ornithological and mammalogical literature to prove that the eggs and young of many species of birds are destroyed by red squirrels. Merriam (1884) says: "I have myself known him to rob the nests of the red-eyed vireo, chipping sparrow, robin, Wilson's thrush and ruffed grouse, and doubt not that thousands of eggs are annually sacrificed, in the Adirondack region alone, to gratify this appetite." Mearns (1878) says that the red squirrel is the worst enemy of the robin, and many other writers cite cases of depredations on robins' nests. Seton mentions a case of a red squirrel eating a young flicker. B. S. Bowdish, in a letter which was the only response I received to a note in the JOURNAL OF MAMMALOGY asking for first-hand information on the destruction of young birds or bird's eggs by red squirrels, says:

> I had, about fifteen years ago, an experience in personally seeing a red squirrel enter a bird house on a pole, bring out a third-grown young bluebird, and sitting on the roof of the house, open the bird's skull and devour the brains, throwing the body to the ground and repeating until the family of young bluebirds had all been destroyed. I have watched a nuthatch building a nest in a cavity, and a week or so later, found the same cavity occupied by a squirrel's nest with the intruder in possession thereof.

Nelson (1918) says: "During the breeding season he spends a large part of his time in predatory nest-hunting and the number of useful

and beautiful birds he thus destroys must be almost incalculable. One close observer believes that each squirrel destroys 200 birds a year."

The passages cited above, and many others of similar purport in ornithological literature, would lead one to believe that the red squirrel is a serious menace to bird-life. But there is another side to the picture. Seton says: "Nevertheless there is a remarkable individuality shown among squirrels in this particular. A family of five lived in a grove of six or seven small trees near my house. In this grove a yellow-throated vireo reared her young under the squirrels' very noses. They must have seen the birds, yet did them no harm. William Brewster has described to me a similar case in which he saw the squirrels leap daily over a robin's nest, but offer no harm to the eggs or the callow young." Thoms (1922) under the title "Are Squirrels Bird Enemies" answers this question in the negative, citing a case of a red squirrel pouncing on a mourning dove on her nest and when she flew off eating the eggs, and of a squirrel throwing young orioles out of their nest, as the only two cases of squirrels molesting birds in his ornithological experience of twenty years, and concludes that "depredations perpetrated by Red Squirrels do not lessen in any appreciable degree the number of birds." Cram (1901) says, "The red squirrel has been generally accused of being an inveterate robber of bird's nests, and I am afraid there is a good deal of ground for the accusation; still, I have never observed him plundering a nest, nor do the small birds generally exhibit any great alarm or anxiety at his presence in the proximity of their homes." To this I can add that in twenty-five years ornithological experience, and in eight years rather intensive study of the red squirrel, I have not come across a case of depredations on nests by squirrels, but on the other hand I have seen three cases where broods of robins were successfully raised in places which a red squirrel visited every day.

Summing up this matter, the facts appear to be as follows: The red squirrel does, more or less frequently, eat both birds' eggs and young birds. People who happen to witness such attacks are usually interested mainly in birds, and often especially in the particular pair whose nest is raided, so that the occurrence makes a deep impression. Any such estimate as "each squirrel destroys 200 birds a year" is, to say the least, a gross exaggeration, as at this rate the number of birds in localities where squirrels are abundant would be seriously reduced, which is not the case. Birds and squirrels have existed together in North America long before man came on the scene, and the settlement

of the country has not rendered conditions more favorable to squirrels and less so to birds, but, if anything, the other way round. It is probable that only certain red squirrels are bird-eaters, just as only certain tigers are man-eaters, and such individuals should be destroyed as soon as evidence against them is obtained.

Another phase of the relation between squirrels and birds is that hawks and owls prey on the red squirrel, as has been mentioned in the section on enemies.

A third phase of this relationship is that some birds, such as the white-breasted nuthatch, downy and hairy woodpeckers, bronzed grackle, blue jay, and house sparrow, rob the red squirrel of the food it has stored in the forks of trees. Both the squirrels I have had under observation lost a large part of their stored food in this way, not so much because most of the food was eaten by the birds, but because the birds in attempting to eat it knocked piece after piece of food out of the forks. Both these squirrels were frequently called upon to defend their stores against these marauders, and when two or more of the birds came into the tree at once they had a very busy time, chasing first one and then another. In chasing these birds the squirrels showed wonderful agility, and many times could, I believe, have caught one of the birds if they had so desired, but in such cases they always jumped short so as not to actually alight on the bird.

Cram (1901) mentions another phase of the squirrel's relation to birds. He says:

> I have never known him to take part in the general outcry against a hawk or owl. . . . . But let him catch a glimpse of an unoffending partridge quietly gathering berries or scratching among the pine-needles, and he immediately pretends to fall into an utterly uncontrollable rage. He slowly approaches the bird with short, scratchy starts, down the tree-trunk, keeping on the opposite side as much as possible, and peering out from behind the rough bark and protecting branches, as if fully aware of his danger and determined on not exposing himself more than necessary, and ever and anon retreating, panic-stricken, back into the shadow, to renew the attack from an opposite direction, barking huskily. . . . . It is wholly out of the question to suppose for a moment that he can have any cause for resentment against the grouse family; and yet, so universal is this habit of scolding and threatening them on every occasion that I find I have gradually fallen into the way, when shooting grouse, of allowing the squirrels to point out my game for me to a certain extent, finding that three times out of four I can tell from the way they chatter whether or not it is a grouse that excites them at the time.

A unique case of the relation of squirrel and bird is that recorded by Roberts (1922) who saw a titmouse gathering hairs from the tail of a red squirrel while the latter organ was hanging down from the crotch of a tree. The titmouse "flew down, perched on the trunk beside the tail and gathered herself a mouthful of hairs, the squirrel seeming to pay no attention. At first I thought that the squirrel was dead, but when I started to walk around the tree he kept himself on the other side as usual. The titmouse followed him around, took a few more hairs and flew away, only to return in a few minutes for more."

## RELATION TO FORESTS

The activities of the red squirrel which might be assumed to have an injurious effect upon the forest are: the eating of immense quantities of seeds of conifers and nuts, the eating of buds, and the barking of trees. As regards seeds and nuts, there is an immense over-production as compared with the number which fall in situations where they can germinate, and a very much larger number of young trees start than can ever reach maturity, so that there is no evidence to show that squirrels, by their seed and nut eating proclivities, in any way interfere with forest reproduction. The eating of buds, even when, as in some cases which I have witnessed, it seems to be rather drastic, does not have any injurious effect upon the trees. The amount of bark which is eaten from any individual tree is usually small, and a branch is girdled only in exceptional cases, so that the aggregate injury from this cause is small.

On the other hand there is little doubt but that the red squirrel plays a more or less important part in reforestation, by reason of the germination of seeds and nuts which it buries in the soil—thus bringing them into the most favorable situation for germination—and then either forgets or does not need.

## PSYCHOLOGY

In the study of any animal the most interesting thing, and at the same time the phase of the subject in which we have to proceed most cautiously in drawing conclusions, is its mentality. I shall not enter here into a discussion of the complications which the study of animal psychology presents, of the pitfalls for the unwary with which it abounds, or of the hotly debated matters of instinct, intelligence and reason as shown by animals other than man, but shall merely remark

that I am familiar with the methods and with the results which have been attained in comparative psychology, and that I believe that close and long-continued observation of red squirrels has given me some glimpses of the mentality of this species.

### GENERAL TEMPERAMENT OF THE SPECIES

Every species of animal exhibits, after one has a sufficient acquaintance with it, a general temperament, which, in spite of individual exceptions, is characteristic of the species. The main outstanding features of the temperament of the red squirrel are: first, vivacity; and second, the ability to "keep its head," that is, not to become panic-stricken in times of danger.

### INDIVIDUALITY

This species exhibits individuality in a marked degree—in general behavior, in actions, poses, food preferences, in fact in every particular in which we can detect individuality in an animal.

An excellent example of individuality was related to me by Dr. J. G. Needham who stated that a certain red squirrel developed the habit of eating the terminal buds, both apical and those of the branches, of spruce trees about his house, and in this way damaged the trees so much that it had to be shot. No other squirrels, of which there were several on the property, exhibited this habit.

### CURIOSITY

Curiosity is an attribute which the red squirrel exhibits very prominently. Any new object is at once seen, carefully approached and investigated. It seems as if the squirrel's method of investigation involves not only smelling a thing but trying it with its teeth.

### OWNERSHIP

The sense of ownership seems to be well developed. Both of the squirrels which have made the maple in my garden their headquarters apparently regarded this tree as their private property, and drove away other squirrels which came into it. It is quite likely that in this case it was not the tree, but the stores that were arranged about it, which they were defending. When the first squirrel was the "owner" of this tree, another male, a little larger and apparently as strong, sometimes came into the tree. It was immediately attacked, and fled, hotly pursued,

without putting up a fight. Once I saw the intruder come into the tree while the "owner" was away, and finding some pieces of meat it proceeded to eat them in such a hurry that it choked. The behavior of a red squirrel which is raiding the stores of another is so absolutely different that one can tell at once that it is not the owner.

The ownership of an article seems to be marked upon it by the squirrel licking it, and by its moving it from the place in which it is found. I have noticed again and again that when a squirrel finds something for the first time it licks it, but when it takes out something which it has had in temporary storage it does not do so, and that a thing when found *must* be moved, even though it is moved only a foot, or sometimes even six inches, and the movement does not result in a better storage place.

### MEMORY

The red squirrel has an excellent memory. This is shown chiefly by the way it remembers where it has put things, even after they have been stored away for several days. Its location memory is, it seems to me, phenomenal. Time after time I have seen it go by the nearest route to something it has stored, take it out, and eat it. I have seen it go to the ground and retrieve nuts when there was to my eyes no evidence that a nut was buried there. The most conclusive proof of the strength of its location memory was given by an incident in the winter of 1924–1925. The squirrel had buried nine nuts in the snow on the balcony one afternoon. During the night there was a heavy snowfall, and the new snow lay over a foot deep on the balcony. Next morning the squirrel came, went without hesitation to each place, dug down, and successively brought up the nine nuts. In many cases there is a possibility that the sense of smell may play a part in the finding of objects, but in the last case cited this seems to be out of the question.

### ANTICIPATION

Anticipation is dependent upon, and directly connected with, memory, and involves the association of ideas. I have seen several instances of anticipation by the red squirrel. On two occasions I saw a white-breasted nuthatch come and peck at a piece of food which the squirrel had stored in the tree; the squirrel drove the bird away, and then, as the nuthatch flew, the squirrel bounded over to another piece of food as if it anticipated an attempt on that piece also. I have also seen it bound over to guard something as soon as the nuthatch came

into the tree. Once, after we had been away for a few weeks, the squirrel, as soon as it saw us at the balcony door, immediately went over to a limb on which we had been in the habit of placing food. The ability to anticipate and forestall an event was shown by one incident. One day I placed a pile of apple peelings and two small apples on a board which projected out over the roof. The squirrel was pulling at a long piece of peeling when one of the apples rolled and was about to fall off the board. The squirrel dropped the peeling and seized the apple just in the nick of time.

### EXPRESSION OF MENTAL STATES

The mental states of the red squirrel are expressed mainly by attitudes, more rarely by the voice. Surprise, fear, curiosity, attention, anger, contentment, all have their characteristic attitudes. The attitude of surprise is either one in which the animal draws itself back on its haunches and allows both fore paws to hang from the sides, or else picks up first one fore paw and then the other. In fear the body is flattened, the head dropped, and the tail held straight out. In curiosity the neck is stretched out to a remarkable degree. Anger is shown by stamping the hind feet and jerking the tail; sometimes by stamping the front feet as well. Attention, especially listening, is shown by folding one paw and placing it against the breast, if the animal is on "all-fours;" or bringing both fore paws against the breast, if it is sitting up.

The voice seems to be used only in anger, pain, curiosity, and in intercommunication. The long rolling "Chir-r-r-r-r-r-r-r-r-r-r" is an intercommunication note, and is never used unless another red squirrel is in the vicinity.

The scolding chatter, which is so familiar to everyone, seems to indicate anger, and is usually accompanied by stamping of the hind feet, which action is sometimes so violent as to become a veritable dance. It might be assumed that this chattering note denotes only excitement and not anger, but from my observations I am inclined to believe that this is not the case, as the squirrel can become very excited without chattering, but as soon as its wrath is aroused by anything, such as a person, cat, dog, another squirrel, or some activity of its own which has not gone to suit it, it chatters. One incident which brings this out rather well was as follows. I had put out two very hard buns for the squirrel. It had some difficulty in getting a firm grip on one of the buns because of the hardness and large size, but finally made off

with it. It ran up the branch from which it usually jumped to the roof of the next house, gathered itself together, and sprang across. But in mid-air the bun slipped and fell to the ground. The slipping of the bun upset the squirrel's leap, but the animal managed to alight safely, though far from gracefully. It looked over the edge of the roof, after the bun, and then chattered and stamped. It soon returned for the other bun, again had a struggle to grip it, carried it up the branch as before, and jumped—with the same result, the bun slipping from the squirrel's teeth in mid-air. After this second failure it was thoroughly angry and chattered and stamped for a long time.

The note of pain is a rather shrill scream. I have heard it from an intruding squirrel when bitten by the owner of the stores it was raiding.

When the squirrel is curious, it often makes a low, "meur-meur-meur" note, and guided by this note I have often been led to observe that a squirrel has discovered something.

### REFLECTION

Reflection is a mental attribute which is supposed to be characteristic only of man. Yet if it is not reflection, how else are we to catalogue the mental state which leads to such actions as the following. I have often seen a red squirrel take a piece of food, start for one place with it, pause a moment, then return and deposit it in some other place. I have also repeatedly seen it store a piece of food in one place, come back a short distance, pause, return to the food, seize it and place it in another location, and I have also seen it return to a piece of food it has just stored in a fork of a tree and re-arrange it. As to what actually passes in the mind of a squirrel we are, unfortunately, completely in the dark; all we can do is to draw inferences from its behavior and keep these inferences as far as possible untinged by our own mentality. But from close and long-continued observation I am convinced that the mental processes of the red squirrel are far more varied and complicated than is usually supposed, especially by those who pin their faith to experiments on animals under entirely unnatural conditions.

### LITERATURE CITED

ADAMS, A. L. 1873. Field and forest rambles with notes and observations on the natural history of eastern Canada.

AUDUBON, J. J., AND J. BACHMAN. 1846. Quadrupeds of North America, vol. 1, p. 128.

BAILEY, V. 1918. Wild animals of the Glacier National Park. Nat. Park Service.

Bell, R. 1898. Nature and development of animal intelligence (Mills, 1898). Appendix.

Burroughs, J. 1900. Squirrels and other fur-bearers.

Cole, L. J. 1922. Red squirrels swimming a lake. Journ. Mamm., vol. 3, p. 53.

Cram, W. E. 1901. Little beasts of field and wood.

Dice, L. R. 1921. Notes on the mammals of interior Alaska. Journ. Mamm., vol. 2, p. 25.

Dice, L. R., and H. B. Sherman. 1922. Notes on the mammals of Gogebic and Ontonagon counties, Michigan. Occas. Papers Mus. Zool. Univ. Michigan.

Fisher, A. K. 1893. The hawks and owls of the United States.

Gibson, W. H. 1903. Highways and byways.

Gilpin, J. B. 1870. On the mammals of Nova Scotia. Trans. Nova Scotia Inst. Nat. Sci., vol. 2, p. 8.

Gosse, A. 1840. The Canadian naturalist.

Hahn, W. E. 1909. The mammals of Indiana. 33rd Ann. Rept. Indiana Dept. Geol. and Nat. Resources, pp. 468–470.

Mearns, E. A. 1878. Birds of the Hudson Highlands. Bull. Essex Inst., vol. 10, p. 9.

Merriam, C. H. 1884. The mammals of the Adirondack region.

Miller, G. S., Jr. 1900. Preliminary list of the mammals of New York. Bull. New York State Mus., no. 33, vol. 7.

Nelson, E. W. 1918. Wild animals of North America. Nat. Geog. Soc., Washington, D. C.

Osgood, W. H. 1900. Results of a biological reconnaissance of the Yukon River region. North Amer. Fauna no. 19.

Paulmier, F. C. 1904. The squirrels and other rodents of the Adirondacks. Ninth Report Forest, Fish, and Game Comm. of New York, p. 339.

Richardson, J. 1829. Fauna Boreali-Americana, vol. 1, p. 187.

Roberts, B. 1922. Bird-Lore, vol. 24, p. 215.

Seton, E. T. 1909. Life-histories of northern animals, vol. 1.

Stone, W., and W. E. Cram. 1902. American animals, p. 174.

Thoms, C. S. 1922. Are squirrels bird-enemies? Bird-Lore, vol. 24, p. 207

*Queen's University, Kingston, Ontario.*

Fig 1

Fig 2

FIG. 1. RED SQUIRREL HOLDING A SMALL PIECE OF FOOD

FIG. 2. RED SQUIRREL AT NEST HOLE

UNIV. OF MICH.

Fig 3

Fig 4

FIG. 3. YOUNG RED SQUIRREL.—CURIOSITY

FIG. 4. YOUNG RED SQUIRREL EATING CEDAR SEEDS

UNIV OF MICH

Fig. 5

Fig. 6

Fig. 7

FIG. 5. RED SQUIRREL RESTING.—ATTITUDE 1
FIG. 6. RED SQUIRREL RESTING.—ATTITUDE 2
FIG. 7. RED SQUIRREL RESTING.—ATTITUDE 3

UNIV. OF TORONTO

Fig. 8

Fig. 9

Fig. 8. Red Squirrel Handling Rose Hip with One Paw

Fig. 9. Red Squirrel Carrying Branches with Cedar Cones

UNIV OF MICH

Fig 10

Fig 11

Fig 12

FIG. 10. RED SQUIRREL DRINKING SAP

FIG. 11. RED SQUIRREL IN ATTITUDE OF FEAR

FIG. 12. RED SQUIRREL SMELLING TRAIL OF ANOTHER RED SQUIRREL

UNIV. OF MICH.

# NOTES CONCERNING A CAPTIVE PRAIRIE-DOG

By E. C. Cates

During the 1925 prairie-dog campaign on the United States Range Livestock Experiment Station, near Miles City, Montana, a young male prairie-dog, *Cynomys ludovicianus*, was captured on May 27. The prairie-dog town in which the animal was found had been baited with poisoned oats the day previous. On going back over the town and rebaiting the burrows of remaining prairie-dogs, I saw this little fellow trying to make his way down into a hole, and upon dismounting and inspecting the hole, found that a female prairie-dog had died in the burrow entrance, thus blocking it from the outside. Becoming hungry it had evidently come to the surface of the ground in search of its mother. It had crowded out past her but could not get back.

I put on a glove and proceeded to capture the young animal as it tried to force its way past its mother down the burrow. It tried to bite at first but upon being placed in a straw hat ceased to fight and was taken to headquarters in the hat before being handled again. At headquarters the young prairie-dog was removed from the hat and placed in a box behind a stove. It did not show any fight this time. After a few minutes handling it permitted me to pet it gently and to pick it up. From this time on it became more of a pet and assumed the friendly attitude of a young kitten.

The young prairie-dog was named "Keogh" in honor of the old remount station, Fort Keogh. Although he never learned to respond to that particular name, he soon perceived that he was wanted when called. The animal was not weaned at the time of capture and his first few meals were obtained from the corner of a handkerchief that had been soaked in milk. From the handkerchief he graduated to bread and milk, and soon to green grass. By the time he had been in captivity two weeks he ate practically everything given him except meat. The animal was allowed to run at will about the kitchen and mess hall at the station and slept behind the kitchen range every night.

Incidentally his curious nature made trouble for him the first day of captivity. While prowling around the station storeroom he decided to investigate a pan of black paint, so jumped into the middle of the pan. He well be-smeared himself before getting out of the pan and caused me some trouble in removing the paint. To pay for the adventure he lost two or three joints from the end of his tail. The last

remaining joint grew the black tip which is characteristic of a prairie-dog's tail.

An accurate record of the young prairie-dog was kept and his natural habits were studied as far as captivity would permit their functioning. From the time he began eating solid foods until his tragic death he favored oats. He was given wheat, corn, barley, rye, all kinds of human foods, various grasses, and in fact everything obtainable that we judged would not harm him. He learned to like sweetmeats and was especially fond of canned sweet potatoes.

When "Keogh" was a month old he was deprived of milk but was given water, of which he drank very sparingly each day. During an experimental period of ten days he was given no liquid at all but just dry foods such as he would get in a prairie-dog town during early spring and late fall. At the end of this period water was again placed before him and he drank very little, as usual when given water every day. This fact indicates that little water is essential to the welfare of these animals.

In drinking water or milk he had a system all his own. The tongue lapped in the same manner as that of a domestic dog, except that it was kept within the mouth, which was submerged.

Keogh was turned out daily on the station lawn where he ate some green grass and cut down considerably more. He played with a collie dog and showed no fear of either dogs or cats as long as some one was near to keep the dog or cat from getting rough.

After about a month in captivity the animal began digging shallow holes on the station lawn. None of the holes were more than six or eight inches deep, and were seldom worked at more than once. Several times during his early captivity he was left out of doors until dark to see if he would dig in; but always he crawled into his nest box about dark.

As the captive grew, a special house was made for him out of an ammunition box, with two compartments, the rear one entirely inclosed except for a hole large enough for entrance. About July 15 Keogh began cutting dry grass and carrying it into the rear compartment for a bed. The first grass cut was laid on the bottom of the box, then additional grass was stacked up the sides of the nest. Upon retiring he crawled into the nest and carefully pulled grass over him until he could not be seen from above when the box lid was removed.

All through July and early in August Keogh shed the baby coat of hair. The first covering was light colored and of a very soft texture.

The new coat was more of a reddish-tan color and was of a coarse texture. During this shedding period his hide was entirely bare in spots as the old hair fell out before the new came in. By August 15 the coat resembled that of an adult prairie-dog except that the tail was minus the black tip on the end.

No exact weights were taken but the growing youngster must have eaten a fourth of his weight in oats, grass, and the like every day. He ate so much that he developed more rapidly than the average prairie-dog in its natural habitat.

Early in August Keogh began to dig burrows a little deeper. Nearly every day he would go down about three feet, then fill the hole again. At about the same time his teeth appeared to be growing quite rapidly, for he worked at the nest box a few minutes every day, chewing at the wood, and also gnawed at bones and rocks frequently. In digging he seemed to delight in cutting roots, small sticks, or any other obstacle that his teeth would impress.

Though very tame this prairie-dog never got entirely over his wary nature. Always in digging he would work awhile and then come to the surface and look around. Even when not digging he had to enter the nest box occasionally to see that everything was all right.

In sinking a burrow Keogh worked not at all unlike other prairie-dogs. The earth was scratched loose and pushed under him with the front feet and kicked out of the hole with the hind feet. When too far below the surface to kick dirt all of the way out, he kicked it as far as he could, came to the surface and looked around, then, beginning at the top, kicked dirt out behind until he again reached the bottom. This process was repeated until the burrow was a clean-cut hole as far as dug. The small chain that was attached to Keogh's collar prevented his going any deeper than three feet. This chain was usually kept attached to prevent the animal from getting into any of the poisoned grain which we always had with us.

Of course, Keogh was our mascot and was taken with us from the experiment station to the Custer Forest. He was moved also from camp to camp about the forest, riding in the nest box, which always had a place in the car. Whenever the car was moving Keogh would crawl into the nest and sleep there until motion ceased.

One of the peculiarities of the little prairie-dog was that he would seldom continue to dig in a hole begun by one of the crew. As a rule he would fill up such holes and start one of his own. Often five or six holes would be started before one was found to suit.

Unlike domestic pets, Keogh was of a very temperamental nature. We soon learned that if he wanted to play he would jump upon our hands and pretend to bite, while if he only wanted to be petted he would lay his head in someone's hand and move it up and down. If treated otherwise than his mood dictated, he displayed signs of anger. The little animal was never forced, however, and thus did not become permanently cross, as many pets of this sort do. Strangers were always warned of his moods, and thus no one was ever bitten, except once. A small boy picked Keogh up by the hind legs one day and was reminded by a nip on the fingers that this was no way to treat a pet.

Occasionally Keogh was turned loose in a building or an old prairie-dog town. While in one particular building he learned to climb up a steep flight of stairs to where I slept. When in a prairie-dog town he usually inspected several burrows, then selected one and cleaned it out in true prairie-dog fashion. Always toward evening he would come out of the burrow and enter his nest in the box. Incidentally a few oats were kept in the box at all times.

About the middle of August black hairs began to appear on the end of Keogh's tail and by September 15 there was a regular black tip as large as that of most young prairie-dogs. The tail always remained short, however. Also about the middle of August Keogh began eating more dry grass, roots, wild seeds, and the like, and not so much green grass. Wild prairie-dogs also change their diet somewhat at about this same period. Oftener they are forced to quit eating green grass before this, however, as there is none.

Keogh learned to be unafraid of most domestic animals, but was always suspicious of sudden movements or noises. Should a bird fly overhead or "cheep" in a nearby tree he would flee to the box. As a rule he came to the door of his house immediately and looked around as if to determine whether it were safe to venture out again.

From the start, Keogh made a "yeping" noise when addressed, but only barked like a wild prairie-dog once that we knew of. On September 11 he suddenly stopped eating, sat up, and barked for about one minute. From about September 1 until his death he occasionally made a chattering noise with his teeth, as if cold. This noise was made on hot days, so must have played some part in keeping the teeth sharpened.

Upon going to bed, Keogh just rolled into the nest head first and curled up with head downward. When disturbed during a nap he merely hid his head and remained curled up.

Keogh was taken to Bozeman on September 16 and chained to his box in the poison-mixing room at the college. The floor appeared to be clean but on two occasions he got enough strychnine into his system to cause convulsions. He was "dopey" for a day or two after each of these occurrences, but in time seemed to recover fully.

As we did not wish to kill the pet, we planned to remove him from the mixing-plant floor about September 26, but death came before we could do so. I saw him lap up some water from the floor and within a few minutes go into convulsions. He recovered from this attack but had two more which were more severe than the first. After about thirty minutes of this suffering Keogh passed out. No first-aid material was at hand, or an attempt would have been made to save the life of this interesting pet.

*U. S. Biological Survey, Bozeman, Montana.*

---

## THE ALASKA RED SQUIRREL PROVIDING FOR WINTER

By Olaus J. Murie

[*Plate 6*]

A number of papers have been published dealing with the food habits of the red squirrel and its provision for winter, but since these were based to a considerable degree on observations in the more southern portions of the range of the species, some notes from the northern part may be of interest for comparison and additional evidence along certain lines.

Red squirrels, *Sciurus hudsonicus*, inhabit all the forested areas of the interior of Alaska under conditions which prevail throughout the subarctic portion of the continent, being found above the Arctic Circle, no doubt to the very limit of forest growth in the Endicott Mountains, practically the northern limit of the range, where temperatures of seventy degrees below zero Fahrenheit sometimes occur and where much cold weather in milder form must be endured. Under such circumstances the red squirrel must provide for winter comfort, since it does not hibernate like its neighbor, the ground squirrel.

As in other parts of the country, two types of shelter are made, namely, underground burrows and nests in trees. I have not examined the ground burrows, but they probably serve as a safe retreat

to which the squirrels flee in case of danger, and for this purpose they make tunnels through the snow leading to the entrances. Generally, when I came upon a squirrel in winter, it took refuge in the ground.

Squirrel nests in Alaska are very similar to those built elsewhere, except that in some localities unusual material is used. Very often several nests are distributed in the same spruce or in adjacent trees. They may be placed either close to the trunk or near the end of a much-branched limb, sometimes built into a tangle of small limbs and twigs. One nest was built in an abnormal, bunchy growth of twigs so common in the spruces. A quantity of fine grass, shredded bark, and a little moss had been packed into the middle of the mass to fit the interstices, but this nest was not as neat nor as cozy as the normal structure.

The nests are generally from ten to twenty feet from the ground and made of fine grass lined with shredded bark, but other material is used when obtainable. The most interesting nest was one found in January, 1921, at Kobi, in the lower Nenana River region. It was placed about fifteen feet up in a slender spruce. The outside structure was composed of grass, moss, bits of paper, a rag, and ravelings from a gunny sack, with a heavy lining of mountain-sheep hair, and was the warmest nest I have seen. The materials had been gleaned largely from a barn near by.

Occasionally a nest is built in an abandoned cabin. One such, a globular mass of grass lined with caribou hair, was placed in a corner of a bunk in a cabin on the Chena River. Evidently the squirrels recognize the superior value of hair as a lining, particularly that from caribou and sheep, and no doubt often use it when available in sufficient quantity. Discarded caribou hides are commonly found in the vicinity of cabins.

Squirrel nests are particularly plentiful in the heavier forests lining the stream banks and are more seldom found in the scattered small black spruce of many districts. The nests undoubtedly serve as homes for the young in the spring as well as for winter shelters, since hollow trees or limbs are scarce in coniferous forests.

An elaborate food cache was reported to me by Otto Geist, who spent the winter of 1923 trapping on Turnagain Arm. In October, squirrels were observed storing food in an abandoned cabin sixteen miles from Anchorage. There were at least two squirrels in the vicinity but Mr. Geist could not be certain how many were interested in the cache. He and his companions watched the activities of the squirrels for about three weeks, at the end of which time about two bushels

of high-bush cranberries, *Viburnum pauciflorum*, two bushels of alder cones, and nearly a bushel of cow-parsnip seeds, *Heracleum lanatum*, had been gathered. Most of this material had been piled up in a bunk. First, there was a layer of spruce twigs, some of which, Mr. Geist believes, were gathered by the squirrels, since some of them were green and the squirrels were seen carrying a few. This activity, however, may have been in connection with gathering spruce cones, since cone-bearing tips are often nipped off, and these need not necessarily have been brought as a foundation for the food cache.

On the bed of spruce boughs had been placed a big heap of high-bush cranberries. All the bushes in the vicinity of the cabin had been stripped of berries. Beside this heap lay a quantity of cow-parsnip seeds, some of them under the berries. The "heads" had been nipped off the stalk and carried in to the bunk and there the seeds had been stripped off and the empty umbels cast to one side. Some of this discarded material had been "shredded." Under the bunk was found a heap of about two bushels of alder cones. On the cabin wall, in a box, was a small nest made of shredded cow-parsnip stems and some bits of rag.

After an absence, the trappers returned in January and found that about a quarter of the berries had been consumed. Apparently only the frozen juice had been eaten, since at one side was a pile of seeds and berry skins. The seeds were not examined minutely to see whether or not the kernels had been removed. At this time another similar but smaller cache was found in a cabin about a mile away.

"Kitchen middens," where squirrels have been accustomed to eat their spruce cones, are very common in Alaska, some of them attaining a large size. Roy King, of Bettles, told me of a large mound of cone scales in a dense thicket of small spruce, the heap measuring nine feet or more in height and more than twelve feet in diameter. Such heaps are often perforated by tunnels, possibly leading to storerooms or shelter.

Red squirrels are attracted to mushrooms in July and August. In July, 1921, while on a visit at Tanana Crossing I found the red squirrels very plentiful, and in practically every spruce where squirrels were found a quantity of mushrooms had been placed, some of them nibbled a little, some completely dried. Mr. Geist described a dead spruce where squirrels were storing mushrooms. He watched them at their work and said that the spruce was "trimmed like a Christmas tree." Mrs. Murie observed the work of squirrels at Ester, a few miles from Fairbanks, where mushrooms had been brought into a cabin and

stored on the rude shelves and in other nooks in the logs, mixed with odds and ends, including nest materials. At one time I had thought that mushrooms were brought into trees merely to be eaten on the spot, that more were gathered than could be used, and that the old dried ones were not necessarily intended for future use, for it seemed improbable that winter stores would be gathered in July. Merriam,[1] Seton,[2] and others, however, have noted the fact that squirrels store mushrooms for future use. Seton indicates that mushrooms are stored in the open on the limbs of trees. Buller[3] has given a number of interesting observations by himself and others, showing that the dried fungi are eaten during the winter. Spruce cones are, of course, the common, ever-present squirrel food, but at certain seasons other supplies become available. In summer and fall mushrooms are eaten and stored, a variety of berries and seeds are used, and at times young birds and eggs are taken. Squirrels often become a nuisance when they enter a prospector's meat cache or meddle with baited traps, and no doubt many other tidbits not mentioned here find a place on their bill of fare.

On September 30, 1921, a squirrel was noted just establishing its winter quarters. The home tree was a scrubby black spruce, not more than twenty feet high, one of a small group on a slope almost denuded of forest growth. A nest was started in the tree and burrows had been dug at the bases of various other trees. A few dried and blackened mushrooms clung to the limbs and a small pile of black-spruce cones had been gathered on the ground. This was a modest beginning, but typified very well the normal activities of the red squirrel in Alaska.

*U. S. Biological Survey, Washington, D. C.*

[1] C. Hart Merriam, Mammals of the Adirondacks. 1884.

[2] Ernest Thompson Seton, Life histories of northern animals, vol. 1. 1909.

[3] A. H. R. Buller, The red squirrel of North America as a mycophagist: Trans. British Mycological Soc., vol. 6, part 4. September 22, 1920.

FIG. 1. A WARM NEST AND A SUPPLY OF SPRUCE CONES INSURE WINTER COMFORT FOR THE RED SQUIRREL

FIG. 2. FOOD STORED BY RED SQUIRREL IN A CABIN NEAR ANCHORAGE, ALASKA. PHOTOGRAPH BY OTTO GEIST

# FOOD SELECTION OF GROUND SQUIRRELS, CITELLUS TRIDECEMLINEATUS[1]

By Frederick L. Hisaw and Frederick E. Emery

Reports from field observations indicate that the food of the ground-squirrel, *Citellus tridecemlineatus* (Mitch.), consists chiefly of seeds. Lantz,[2] in speaking of this species, says, "Their chief food is grain and seeds of grass and weeds" and adds, "They also consume a considerable number of insects of various kinds, and will eat dead birds and even small rodents." Burnett[3] in writing of the economic importance of two varieties of ground squirrels, *Citellus t. pallidus* and *Citellus t. parvus*, that are closely allied to the one reported here, states that their food consists of grain of all kinds and that their favorite food is corn. He also mentions that they eat grasshoppers, crickets, cutworms and beetles in large numbers and, in confinement at least, will catch and devour mice with the eagerness of a cat. The same author[4] also notes that one of these squirrels, which was kept in captivity for some time, would eat grasshoppers in preference to any other kind of food.

The insectivorous propensities of *Citellus tridecemlineatus* were first brought to our attention during the summer of 1920 and a few experiments were performed to determine the importance of insects in their diet from the standpoint of food preference. Two animals that had been in captivity for some months and had become tame were used. Each was kept in a large cage about ten feet square and was furnished with a nesting cage in one corner. Each cage had a solid concrete floor and the sides were of fine mesh wire cloth. This made it possible to offer live animals in the ration and to collect and determine the amount eaten. The insects were fed alive. After being weighed they were pinned in a single row to a long piece of rubber carpet to keep them from scattering over the cage. Insect pins with small heads were used for this purpose so that when an insect was chosen by the squirrel it could be pulled off of the pin and killed.

[1] Contribution No. 87 of the Zoology Department, Agricultural Experiment Station, Kansas State Agricultural College.

[2] Lantz, D. E. 1904. Kansas Mammals in Their Relation to Agriculture. Kansas Agricultural Experiment Station Bulletin No. 129.

[3] Burnett, W. L. 1918. Rodents of Colorado in their economic relation. State Entomologist Circular No. 25.

[4] Burnett, W. L. 1914. The striped ground squirrels of Colorado. State Entomologist Circular No. 14.

The seeds offered in the ration were weighed and placed in shallow dishes close by the insects. The size of the cages permitted the rations to be placed about six or seven feet from the opening of the nesting boxes so the squirrels would have a chance to see each article of food before making a choice.

The criteria for estimating food choice were the order of selection and amount eaten of the articles offered in the ration. It was taken for granted that if different kinds of food were presented simultaneously, and each kind made equally accessible, that the animal would select first the food which it liked best. It also seems logical that under the same conditions an animal would eat more of the food that it relished most. Out of twenty-seven trials as described above, grasshoppers were chosen first twenty-two times, crickets twice, a wasp once, and corn twice, showing a very decided preference for insects and particularly grasshoppers. These selections were made from an extensive series of insects and seeds and the constancy with which the choices were made, seems to leave little doubt as to food preference. Yet it was of interest to know what the squirrels would do, as to the amount of each eaten, when offered only grasshoppers and corn, their favorite insect and grain. An examination of the accompanying table will show that under these circumstances the squirrels also seem to show a preference for grasshoppers. It is rather difficult to standardize these data accurately so they can be compared one with the other. The weight of the corn offered is that of the whole grains while the weight eaten includes, for the most part, only the embryos. In the case of grasshoppers the amount consumed can be compared directly with the amount offered as almost the entire insect was eaten, only the wings and parts of the legs remaining. Peas and wheat, when eaten, were devoured entirely and in the case of oats only the husks were discarded. When the data recorded here are compared in terms of grams it is found that squirrel No. 1, when offered grasshoppers and corn, ate 4.72 times as much of the former as the latter, while the choice of No. 2 was 3.49 grams of grasshoppers to one of corn.

When other grains were added to the ration (see table) fewer grasshoppers were eaten. Squirrel No. 1 ate only 3.38 grams more of the insects than of the grain and squirrel No. 2 ate 19.8 grams more grain grasshoppers. It is also of interest that in this part of the experiment squirrel No. 1 ate more oats and wheat than corn and squirrel No. 2 ate more oats than corn. It should also be mentioned that possible errors in these experiments were in favor of the grains because a few

times all of the grasshoppers offered were devoured while on all occasions a surplus of grain remained. It was also noticed that usually when more insects were offered than could be eaten less grain was taken.

That these squirrels are capable of capturing active prey in nature was demonstrated by the dexterity with which they could catch grasshoppers released in their cage. They pursued insects with the agility of a cat and captured them with their front paws. As soon as a grasshopper or cricket was in hand the squirrel usually began eating the insect's head; at other times the abdomen was bitten first, but in these instances the kicking of the insect caused the squirrel to shift its attack to the anterior end. Beetles, butterflies, and small insects were killed by biting, the attack being directed at no particular part of the body.

TABLE 1

*Food choice of* C. tridecemlineatus *when offered corn and grasshoppers, and when offered grasshoppers in a ration which contains several grains*

Amounts expressed in grams

| ANIMAL | CORN | | GRASSHOPPERS | | PEAS | | WHEAT | | OATS | | DAYS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Offered | Eaten | Offered | Eaten | Offered | Eaten | Offered | Eaten | Offered | Eaten | |
| No. 1 | 227 | 44.2 | 227.8 | 199 | | | | | | | 14 |
| No. 2 | 234 | 59.1 | 239 | 206.4 | | | | | | | 15 |
| No. 1 | 105 | 17.8 | 95.8 | 76.3 | 60 | 1 | 60 | 31 | 60 | 23 | 6 |
| No. 2 | 157.5 | 34 | 120 | 90 | 70 | 9 | 70 | 27 | 70 | 40 | 7 |

Woolly caterpillars were killed with the claws of the fore feet. This was accomplished by the squirrel holding its claws at an angle perpendicular to the body of the larvae and striking very rapid blows much like a musician strikes the keys of a piano.

The fore feet were usually not used in filling the cheek pouches with small grain such as wheat. The wheat was taken into the mouth and, as it accumulated, was packed in the pouches by lowering the nose and shortening the neck. If the wheat was eaten immediately it was not taken from the pouch. The animals would chew much as a cow chews her cud and the size of the pouches would decrease as the grain was masticated and swallowed.

These few observations indicate that these squirrels are at least as insectivorous as they are seed-eating in their habits. This opinion is

also borne out by data obtained from quantitative examinations of stomach contents of animals captured at different times during their active period. Burnett (1914) examined forty-six stomachs of *C. t. pallidus* and *C. t. parvus* killed during the months from April to September, inclusive, and an analysis of these data, and those of others, shows quite clearly that insects are the chief diet of these mammals during summer and fall when insects are most abundant. Of the thirteen stomachs examined in July, August and September, Burnett records eight as being "full" of insects, chiefly grasshoppers, one "half-full" of grasshoppers, three almost empty but containing "some" grasshoppers, and one nearly empty but containing a small amount of corn. This seems to indicate that under natural conditions grasshoppers are preferred when they can be obtained.

The conclusion reached by Bailey[5] after an examination of eighty stomachs, was that more than half of the contents consisted of insects. He found the percentage of animal matter to be 53.9, of vegetable matter 44.4, and indeterminate matter 2.7.

These observations also have an economic bearing, as the striped ground-squirrel is included among the great host of rodents which are accused of destroying cultivated crops. Most all reports of damage done by these squirrels are received in the spring and are accusations of destroying planted seeds. It is of importance to note, in this connection, that this is also the time of year when insect life is scarce. It may be that these animals are predominantly herbivorous in the spring when there are few insects obtainable, while in the summer and fall they are chiefly insectivorous. The damage done by these squirrels is seldom of serious extent because they do not venture far into cultivated fields, and from the data presented here it seems that they are economically beneficial, and especially is this true when they are found in meadows and grasslands which are their natural habitats.

*University of Wisconsin, Madison, Wisconsin,*
*and University of Illinois, Urbana, Illinois.*

[5] Bailey, Vernon. 1893. Bulletin No. 4, Division of Ornithology and Mammalogy, United States Department of Agriculture.

# RANDOM FLASHLIGHTS

By Tappan Gregory

[*Plate 7*]

Last June (1925), it was the twenty-eighth as a matter of fact, my brother and I, while wandering along an old road near the shore of Lake Superior in Marquette County, Michigan, noticed some fresh fox tracks. We knew of an old den a few rods from the road and turned in that direction to see what story it might tell. There we found a portion of the hind foot of a rabbit apparently quite recently killed, which seemed to indicate the possibility of a picture. It took several hours to pick up a camera and other paraphernalia necessary to the making of a set in which the animal might photograph itself. Perhaps the fox was still in the neighborhood when we first visited the spot and was minded to move upon discovering our presence, or it may be that the mouth of the den simply offered a handy place in which to make a meal close to where the rabbit had been captured. In any event, nothing crossed our trip wire during the succeeding two nights. On the first of July a white-footed mouse was added as bait. After leaving this set, I spent quite a little time that afternoon building a balsam screen near a salt lick. The deer were coming in every day and it seemed to me that the opportunity for flashlights there would be distinctly improved if the flash could be discharged by hand at just the right moment, instead of by the animals themselves. The difficulty with set camera pictures of deer moving along a trail or approaching a salt lick is that as a rule the animals appear with their heads down in most unsatisfactory pose. We tried my improvised blind once or twice but the flies and mosquitoes were so troublesome that the experiment seemed hardly worth the effort. I think there was at least one camera set by this lick for about three months and something like forty deer pictures collected during that time, of which only a small proportion was of outstanding merit. My own interest inclined a little more towards working on the smaller mammals and I was pleased to see that the mink were still traveling along the sand beach on one of the inland lakes where we had some luck with them in 1924. A visit to the fox set on July 2 showed the flash set off, the trip wire unbroken and the mouse still there, bearing on its flank a mark as of a claw or tooth. No fresh tracks were visible in the vicinity and our apprehensions crystallized into realization of disappointment when we developed the

plate and discovered a blue jay rising with the mouse in its claws. The pursuit of automatic flashlights of mammals is just filled with such incidents. So many things can happen to interfere with success. The really worth while results are few and far between and no end of patience and perseverence is required. Then sometimes, quite unexpectedly, a most satisfactory experience will occur to give the necessary encouragement. We took the camera from the fox den and set it by our favorite sand beach. It must have taken about an hour to make this set, largely due to the fact that the midges were almost intolerable. Not having any very choice bait, we attached a small crawfish to the trip wire for whatever it was worth. As it turned out, this was unimportant that night.

When everything was in order, we left the beach and set off into the woods to our blind at the salt lick. The trip home from there was interrupted at about 10:15 p.m. by a flare of light in the sky and the sound of the flash from our first set. Turning back, we heard a chattering of teeth as we approached the camera and found a good-sized porcupine climbing a nearby tree. Its tracks showed plainly on the sand, convincing us that it was responsible for the discharge of the powder, though the trip wire was unbroken. Inasmuch as the bait was unharmed, we reset the same way as before. The porcupine had apparently been to the water's edge and tripped the wire on its return without paying any attention to the crawfish. Just a sort of lucky, random shot. Of course, it is a simple matter to take pictures of porcupines, but not so easy to obtain results that are as eminently satisfactory as the image which this particular one left for us on the plate. Unfortunately, it was cracked, which necessitated some retouching merely to eliminate, as far as possible, the marks of the cracks, not otherwise changing the outline of the animal.

The next visitor at this particular set came during that same night. We found its infinitesimal tracks at the bait the next morning—a white footed mouse, *Peromyscus m. gracilis* I suppose. It looks in the picture as though this little fellow had discharged the flash by worrying the crawfish. By contrast to the delicacy of the set, the flash itself was peculiarly sturdy. On visiting it in the morning, we discovered that a part of our lamp had been blown off by the concussion and carried away, never to be retrieved.

The weather was quite oppressively hot during these days in early July and it seemed advisable to keep fresh bait at our beach set as much of the time as possible. With this in mind, we substituted a mouse for

Fig 1 Fig 2

Fig 3

FIG. 1. A PORCUPINE BLUNDERS THROUGH TRIP WIRE

FIG. 2. WHITE-FOOTED MOUSE AT CRAWFISH BAIT

FIG. 3. CAMERA AND FLASH AT BEACH WHERE PORCUPINE AND MOUSE WERE PHOTOGRAPHED

UNIV. OF MICH.

the crawfish on the third of July and the next day found fresh mink tracks, passing within an inch or so of this choice morsel, but the trap was unsprung. I mean by that, the break in the electric circuit had not been closed by pressure on the trip wire. In the neck of the mouse we found a good-sized hole full of ants and bugs. The general appearance indicated that these insects were responsible for the hole, but I wonder whether or not the mink could have taken one bite and then let go without displacing the bait sufficiently to bring together our contacts.

There followed a period of about ten days when two or three cameras were kept set on various sand beaches, baited largely with small rock bass, varied occasionally with a mouse or some other substitute. Little of interest came our way during all this time and the net results in pictures consisted of a couple of skunks, the head of another mouse, part of a chipmunk and the blurred image of a red squirrel. Once in the early morning, while I stood examining the signs on one of the beaches, I heard the report and saw the smoke from the flash of another set which I had just left and, when I turned back to it, found two tracks of a great blue heron in the sand at the water's edge and the mark of its beak by our fish bait. Twice, as the pictures showed, the fish was seized by a herring gull in daylight, and once what looked like the tracks of a fox appeared where the animal had apparently jumped to the beach from a clump of grass and right on into shelter again. I thought to circumvent the red squirrels, which were accustomed to run back and forth across the beach, by adding cross wires to the main trip and finally succeeded in this way in obtaining a picture, but these little creatures in the course of their travels move too rapidly to be stopped by a shutter working at 1/200 second. We saw mink tracks only once again, on the morning of July 13, made the night before, or before our arrival that day.

*Chicago, Illinois.*

# NOTES ON THE SEXUAL CYCLE OF THE PACIFIC CETACEA OF THE GENERA MEGAPTERA AND BALAENOPTERA

By Earl Theron Engle

Relatively little is known regarding the life history of the larger Cetacea. The data are scattered and very fragmentary. It is not known at what age or size the young whale becomes sexually mature and whether breeding is seasonal or occurs throughout the year. The duration of gestation and lactation are not known and the opinions on these matters, some of which are supported by scattered bits of evidence, differ greatly. It was with the hope of extending the data on some of these questions that the present investigation was undertaken. Through the courtesy of Dr. B. W. Evermann, director of the California Academy of Sciences, and Joseph Mailliard, curator of mammalogy and ornithology, the writer spent the last three weeks of August, 1925, at the shore whaling station of the Californa Sea Products Company at Trinidad, California.

Only nine whales were taken during this period, owing to stormy weather and an apparent scarcity of whales in that vicinity. Three male and two female finbacks, *Balaenoptera physalus*, and three male and one female humpbacks, *Megaptera nodosa*, constituted the catch.

Measurements, based on those of Andrews[1] were taken of all whales. Samples of the stomach contents and specimens of external and internal parasites were collected for study by specialists, but the particular object of this investigation was to seek evidence regarding the reproductive cycle by an examination of the reproductive system of both sexes. So far as is known to the writer no attempt has been made to solve the sexual cycle of Cetacea by a study of the histological characteristics of the testes and ovaries. The method and results of such studies for the smaller mammals are well known.

The territory of the whaling operations from the Trinidad station during the period of this investigation extended over an area having a radius of about seventy-five miles. Animals which were brought to the station for flensing had been dead on an average for ten to twenty hours. Despite this fact, the tissues which were fixed in 10 per cent formol showed a fair state of preservation, and a satisfactory examination was possible.

[1] Andrews, R. C., 1916. Monographs of the Pacific Cetacea. II. The Sei Whale (*Balaenoptera borealis* Lesson). Memoirs Amer. Mus. Nat. Hist., n.s., vol. 1.

Since all of the gross examinations were made hurriedly during the flensing and cutting up process, accurate dissection was impossible.

The testes do not lie in the abdominal cavity, as is commonly stated, but are situated in the pubic region in a pouch which appears to begin at the subcutaneous inguinal ring. From this they may readily be drawn into the abdominal cavity. The weights of the ovaries and testes and of the brains of two animals are recorded in table 1. The gonads of several of the animals were not obtained until after the animal had been dismembered. Hence it was impossible to differentiate between the right and left organ. In three cases where it was known, the right testis was the heavier. The testis was freed from the tunics and epididymis before weighing.

TABLE 1

| SPECIES | SEX | LENGTH ESTIMATED WEIGHT | | TESTES WEIGHT | | OVARIES WEIGHT | | CEREBRUM | | CEREBELLUM | | BRAIN, TOTAL WEIGHT | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *feet* | *tons* | *oz.* | *oz.* | *oz.* | *oz.* | *lbs.* | *oz.* | *lbs.* | *oz.* | *lbs.* | *oz.* |
| B. physalus..... | M. | 47 | 42 | 9 | 8.5 | | | 8 | 13 | 3 | 0 | 11 | 13 |
| B. physalus..... | M. | 52 | 47 | 24 | 21 | | | | | | | | |
| B. physalus..... | M. | 61 | 56 | 54 | 45 | | | | | | | | |
| M. nodosa..... | M. | 34 | 30 | 13 | 13 | | | | | | | | |
| M. nodosa..... | M. | 41 | 36 | 32 | 29 | | | | | | | | |
| M. nodosa..... | M. | 43 | 39 | 16 | 13.5 | | | 9 | 11 | 3 | 1 | 12 | 12 |
| B. physalus..... | F. | 59 | 54 | | | 7 | 7 | | | | | | |
| B. physalus..... | F. | 63 | 60 | | | 19 | 16 | | | | | | |

An advanced stage of spermatogenesis was lacking in all of the testes studied. In all of the seminiferous tubules a well defined, peripheral layer of spermatogonia was present. Nuclear degeneration was apparent in the cells of a few tubules, while a small number showed distinct mitotic figures. A few primary spermatocytes were present in each tubule and in testes from two animals it is possible that secondary spermatocytes were also present. The sustentacular cells of Sertoli were small and not abundant. The interstitial cells of Leydig were small but numerous. Spermatids or spermatozoa were not present and seminal fluid was not expressed from the ductus deferentes at the time of the examination.

The first female taken is not included in the table. It was a 44-foot humpback whale which was in an advanced state of lactation. The mammary glands, which lie on the ventral surface of the abdomen, and

the paired nipples, on either side of the genital opening, were six feet long, eighteen inches in greatest diameter, and six to seven inches in thickness. The alveoli were full of thick, sweetish milk, not unlike the condensed milk of commerce in consistency. No suckling calf was noticed by the gunner of the boat and it unfortunately was impossible to obtain the ovaries.

The ovaries of the 59-foot finback, *Balaenoptera physalus*, contained no recent corpora lutea in either ovary, although microscopic examination revealed several corpora albicantes. Many small oöcytes were present throughout the cortical region, but no well-developed ovarian follicles were found. The mammary glands were inactive and no conceptus was found in the uterus.

The conditions were very similar in the genital organs of a 63-foot gray finback. No large corpora lutea or mature ovarian follicles were noticed.

The evidence obtained for the reproductive cycle of the female whale is of slight value. Beyond the facts that one whale was in active lactation in August with a calf evidently large enough to desert the female after her death, and that the other two whales had ovulated previously, nothing was learned.

The histological picture of the testes suggests several interesting possibilities. Since well-preserved spermatogonia and primary spermatocytes, but no spermatids or spermatozoa, were present, it is evident that the absence of the latter can be explained only by the assumption that spermatogenesis had not proceeded to that point. It was not due to post mortem degeneration.

The stage of spermatogenesis in the 34-foot *Megaptera* is very similar to that in the 61-foot *Balaenoptera*. Although the number of animals and the fixation of the tissue does not justify a positive statement, the evidence suggests the possibility of a sexual rhythm in the whale such as is known in other mammals, active spermatogenesis occurring only during a restricted breeding season. It is also suggested that the animals, all of which were sexually mature, were approaching the breeding season. The evidence supports the data accumulated by Andrews and others, and the opinion of the whalers, that the whales of the north Pacific breed during the winter months.

There is no way to determine whether the young 34-foot humpback had been sexually active in the preceeding breeding season, but it is probable that it would have been in the next breeding season. An examination of the bones of the manus and the cervical vertebrae of

this specimen after maceration in the vats, showed that the animal was very young, for the carpal bones consisted of a small ossified center in a large cartilaginous mass. The component parts of the cervical vertebrae had not yet fused into a solid bone and the epiphyseal plates were not joined to the body of the vertebrae.

These findings merely suggest that the whale becomes sexually mature while still quite young. Since the newborn *Megaptera* may be 16 feet in length and suckling calves 24 feet in length, according to data furnished by Captain F. K. Dietrick of the California Sea Products Company, it seems safe to assume that this species may become sexually mature by the third year.

*Department of Anatomy, Stanford University, California.*

---

## NOTES ON THE LIFE HISTORY OF SYNAPTOMYS

By Jean Linsdale

Although skins of mice of the genus *Synaptomys* are in several collections, these animals have not been found regularly at many localities in the United States. With a few exceptions all that have been captured have been taken accidentally by collectors who were trapping for other mice. The published accounts of the habits of this interesting and strange mouse have been so diverse and so few that it seems desirable to record any facts regarding its life history that may be obtained, even if they do not form a complete account.

*Synaptomys helaletes gossii* (Coues) ranges farther west and south than the other subspecies in the subgenus *Synaptomys*. The type of this subspecies was collected at Neosho Falls, Kansas, in the winter of 1865–1866 by B. F. Goss. Since then, others have been taken in Kansas at Leavenworth, Topeka, and Manhattan.

In the winter of 1924–1925 this mouse was found by myself and others at several places in Douglas County, Kansas, within seven miles of the University of Kansas. Mice had been collected in that vicinity, and even in the same fields in which *Synaptomys* was subsequently found, for many years without finding this particular species. On December 7, 1924, a female was caught in a trap set in an old cemetery one-half mile southwest of the campus of the University of Kansas. Thirty-two unbaited mouse traps were set near this spot in a small area ten by thirty yards in extent, and six *Synaptomys* were

caught in them on December 8. There was a sudden drop in temperature to twenty degrees Fahrenheit at about seven o'clock in the morning of December 8. None of the traps was sprung on the following day when they were moved, and none was set there again until February 5, 1925. Traps set in this small area caught one *Synaptomys* on each of the following dates in 1925: February 5, 19, and 25, and March 4 and 6.

Mice of this genus have been found in a variety of habitats in the different parts of the United States from which they have been reported. Some have been taken on low, wet ground and some have been taken on high ground. The ground in the cemetery in which the mouse was first found in Douglas County is a little higher than the other land in the vicinity and was covered with a thick growth of tall, native prairie grass which made a dense mat. There were a few trees in the cemetery. A Cooper hawk was flushed from one of the trees. Slate-colored juncos and tree sparrows were found in the trees and in the grass. A flock of twenty bob-whites wintered in the cemetery. In the same runways in which the *Synaptomys* were caught, specimens of *Microtus ochrogaster*, *Reithrodontomys megalotis dychei*, *Mus musculus*, and *Peromyscus leucopus noveboracensis* were also taken. Several *Sylvilagus floridanus mearnsi* were started from forms in the grass. Several of the bog-lemmings were taken in runways in blue grass on a south slope one-fourth of a mile west of the campus. In addition to the mice found in the cemetery a specimen of *Cryptotis parva* was taken in the runways. Other bog-lemmings were taken at the edge of a seepy place in a blue-grass pasture northwest of the campus. All the mice were taken in runways of the kind generally used by *Microtus*.

The stomach and intestinal contents of all the bog-lemmings examined were uniformly bright green. The color showed plainly through the intestinal wall and was much brighter than in *Microtus* taken at the same place at the same time. Pieces of unchewed green grass were found in the mouth of a bog-lemming on several occasions. The mice were caught in traps that were baited with oatmeal and with raisins.

A female was caught alive, with raisin bait, in a runway between ten in the morning and five in the evening on February 25, 1925. When placed in a small cage it did not appear to be especially nervous, and came to sniff at a dead *Microtus* which was held next to the wire. It spent most of the first evening after its capture quietly in one corner of the cage. Occasionally, the mouse roused itself and turned around,

or was busy cleaning its fur for a few minutes. When the lights were turned out in the room the animal moved about its cage. When a bright light was placed near the cage the mouse attempted to get into the shadow of a board. A sudden sound in the room made the animal start and cease, momentarily, whatever it was doing. When a person walked close to the cage the mouse appeared to be not frightened and it came to the wire as if curious. A "squeak" caused it to run to the opposite side of its cage, where it stopped.

*List of specimens collected*

| DATE | LENGTH | TAIL | HIND FOOT | EAR | SEX | WEIGHT |
|---|---|---|---|---|---|---|
| | *mm.* | *mm.* | *mm.* | *mm.* | | *grams* |
| December 7, 1924 | 123 | 21 | 20 | 10 | ♀ | |
| December 8, 1924 | 124 | 19 | 21 | 10 | ♂ | |
| December 8, 1924 | 133 | 18.5 | 19 | 10 | ♀ | |
| December 8, 1924 | 136 | 20 | 21 | 10 | ♂ | |
| December 8, 1924 | 120 | 19 | 21.5 | 11 | ♀ | |
| December 8, 1924 | 123.5 | 23 | 21.5 | 11 | ♂ | |
| December 8, 1924 | 126 | 21.5 | 21 | 11 | ♂ | |
| February 5, 1925 | 114 | 17 | 20 | 10 | ♀ | 26.82 |
| February 19, 1925 | 137 | 20 | 22 | 9 | ♀ | 41.98 |
| March 4, 1925 | 135 | 22 | 21 | 11 | ♀ | |
| March 13, 1925 | 130 | 17 | 20 | 11 | ♀ | 37.6 |
| March 13, 1925 | 136 | 20 | 20 | 11 | ♂ | 42.6 |
| April 1, 1925 | 124 | 19 | 20 | 11 | ♂ | 32.6 |
| April 1, 1925 | 115 | 17 | 19 | 10 | ♂ | |
| April 2, 1925 | 148 | 21 | 21 | 8 | ♀ | |

After the first day the mouse used cotton, that was placed in the cage, of which to make a nest in a glass fruit jar. Raisins that were placed in the cage were eaten at first. Later, the animal stopped eating raisins and ate dried alfalfa and oatmeal. During the day the mouse came out of the nest to eat at intervals of about thirty minutes. Eating was frequently interrupted to drink water, which was done by lapping with the tongue. This animal died on March 5. Its digestive tract contained food.

Two other instances of the activity of the bog-lemming in the day-time were noted. A mouse-trap was set in a runway near Lawrence at four o'clock on April 1, 1925. I heard the snap of the trap before I had moved ten feet away, and, on returning to the trap, found in it an immature male *Synaptomys*. While setting some traps at the edge of

a small stream near a bog in the vicinity of Douglas Lake, Michigan, in the summer of 1924, with Dr. Francis Harper, I saw a mouse run very rapidly through a runway at the edge of the water. A trap, set in the runway, caught a *Synaptomys fatuus*.

A female caught at Lawrence on December 8, 1924, had in its uterus four embryos, each seven millimeters long. The right horn of the uterus contained one embryo and the left horn contained three. There were four pectoral and two inguinal mammae. A female taken on February 19, 1925, also had four pectoral mammae and two inguinal. A female collected on March 13, 1925, contained five embryos, each nine millimeters long, three in the right part of the uterus and two in the left part. This one had two pectoral and two inguinal mammae.

Concerning the number of mammae, Coues and Allen say in their "Monographs of North American Rodentia" (U. S. Geol. Surv. Terr. [Hayden], p. 236) that in a female, apparently nursing, they found two pairs of pectoral mammae and one pair of inguinal mammae, without being able to make out any intervening ventral ones. They add that it is probable that the species possesses a ventral pair making eight teats in all. Butler and Quick, on this question, say in "The habits of some Arvicolinae" (Amer. Nat., 1885, p. 114) that in all suckling females that have been brought to their attention the mammae have apparently been four, one pair pectoral and one pair inguinal.

Two of the specimens that were taken at Lawrence had scars which might indicate that either they frequently quarrel among themselves or that they commonly have conflicts with other mice, possibly *Microtus*. One had several long cuts on the body and the other had holes in its ears. Both of these animals were females.

In addition to the specimens listed in the table on page 53, all of which I measured and skinned, about as many more were collected near Lawrence in the spring of 1925 by collectors for the Museum of Birds and Mammals of the University of Kansas. All the skins that I collected were given to this museum.

*Berkeley, California.*

# GENERAL NOTES

## HOW DO SQUIRRELS FIND BURIED NUTS?

An adult fox squirrel (*Sciurus niger rufiventer*), believed to be a female, during the winter of 1924–25 formed the habit of coming to the side porch of my house in Ann Arbor, Michigan, to secure black walnuts kept there in a box. Her visits continued through early April, and gave opportunity for a number of observations on her habits. She came to the porch usually at least once a day, and often would carry off several nuts in rapid succession. In March the box of nuts was removed and in the same position was placed a shallow box filled with dry sand. In the sand of this box some black walnuts were buried or partly buried, while others were placed on top the sand. The surface of the sand was smoothed off from time to time so that the tracks of the squirrel would indicate when she had visited the box, and what she had done while there.

Even though the squirrel came frequently to the box to secure nuts, and although she readily took the nuts placed on top of the sand, she never found a buried nut, although there were usually three or four, barely covered, in the box. In her visits she ran all over the box, and occasionally dug into the sand, but never at a location where a nut was buried. If a nut were only partly buried, with the black tip projecting, sooner or later she would find it; but if the projecting part of the nut were dusty, and its characteristic black color thereby obscured, she usually did not find it. If no nuts were placed on top the sand the squirrel would search about and then depart without finding the buried nuts.

I had supposed that these squirrels found buried nuts largely by the sense of smell, but the behavior of this squirrel indicates that the species may not use smell in any effective way to locate black walnuts buried in dry sand. It is possible of course that nuts buried in damp soil might give off an odor recognizable by a squirrel, even though nuts buried in sand did not.

If squirrels do not find buried nuts by the use of the sense of smell, the presumption would be that they remember the place where they have buried each nut that they find. This would require a well developed memory though not necessarily a perfect memory, for squirrels undoubtedly fail to find many nuts they have buried.

Frost[1] has made an interesting observation on the gray squirrel which indicates a memory of the location of buried nuts, and gray squirrels and fox squirrels show many similarities of behavior.

It is to be hoped that similar experiments and observations can be made by others who have wild squirrels available, as other individual fox squirrels might react quite differently from the one above described.—L. R. Dice, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

## NOTES ON THE FOOD HABITS OF THE GRAY SQUIRREL

Autumn is a squirrel's time of plenty. In the suburban locality of Garden City, Long Island, New York, these squirrels have been numerous for several years. There is little there in the way of nut or acorn bearing trees, but I have

[1] E. P. Frost, 1913. Journ. Animal Behavior, vol. 3, pp. 145–146.

seen a squirrel splitting the heads of fallen winged seeds of the Norway maple to neatly extract the kernel (October 5, 1924); and removing the stones from the fruit of the flowering dogwood. One was observed to carry a ripening dogwood fruit from the outer leafy portion to the central branches of a small tree, and sit there nibbling at same while turning it in the fore paws. Below the tree were several whorls of berries more or less complete, cut off with a short stem still attached, half berries with kernel removed, and so-forth (September 16, 1923). One or two squirrels resorted several mornings in succession to crack and nibble fallen seeds under *Cornus mas* (about November 1, 1925).

A gray squirrel which was attracted by kernels of whole yellow corn spilled about the door, ate the heart or germinal portion of each, discarding the remainder, the major part of the kernel (November 1, 1921).

Personal observations on the well known habit of burying nuts were of interest to me. One fall or early winter the children dispensed many peanuts to one or more squirrels, some of which were taken a short distance and buried. We saw no evidence of any being disinterred until frost and snow had locked them in the ground. The following April, however (April 9, 1921, shortly before 5 p.m.), there was a squirrel digging up and eating those peanuts. No chance of its remembering where each one had been placed. It worked slowly and carefully about until one had been located, obviously by sense of smell, then dug down with the fore paws through the short new grass and the sod for an inch or rather less, sat up and ate the nut it had secured.

As fall is the time of plenty for the squirrel, spring may be supposed to be the time of want. At this season they rely a good deal on the swelling buds of certain trees. First it is the white or silver maple, in the branches of which they may be seen in late February or March, singly or two or three in a tree, often over snow, in the early morning and to a less extent the late afternoon, comparatively rarely in my observation at other hours of the day. They bite off the terminal twigs and holding them conveniently nip off and nibble a few buds, but almost always drop that twig before finishing it and reach for another. I have seen one on February 19 (1922), the sun low and bright in the west over melting snow, pausing here and there in the outer branches of an elm to reach for and nibble at small twigs, presumably eating the buds; but as a rule it is somewhat later that they turn their attention to the American elm.

In 1924 I have recorded a number of observations of the gray squirrel feeding on white maple buds. The first is February 12, about 5:30 p.m., light just failing, still and snowing a little. In the mornings they were noticed thus employed from about 8:30 a.m. in February to about 7:30 a.m. in March. March 12 a squirrel was up and at his budding very early despite a gale with snow, at about 6:45 a.m. By the time the white maples are coming into flower (March 21 in 1924) squirrels as a rule turn their attention elsewhere; but on March 30, about one-half hour before sunset one was budding in the top of a flowering pistillate tree, choosing this in preference to a staminate tree nearby with showier blossoms.

On April 10, 1922, at sunset I noticed a squirrel reaching for blossoms which were just beginning to set fruit in a small white maple.

I find a record of the gray squirrel cutting off elm tips in April, feeding on the swollen and opening buds (April 3 and 10, 1924, shortly after sunset). Though they usually desist from this about as such trees come into full flower, a little

later they may turn to the elm again. On May 5, 1921, I recorded one in the top of a young tree shortly after six o'clock of an overcast afternoon biting off small twigs and turning them rapidly in its two front paws as it ate the newly formed seeds. Some of their wings eddied down, others remained attached with the central seed removed, as could be seen from the twigs which had been dropped, on which there were also intact seeds which had been passed by.

The gray squirrel feeds on flowers of the sugar maple as the leaves and flowers of that tree open. April 14, 1924, just after sunset, three squirrels were up in a small sugar maple, feeding on the swollen maple buds, and I picked up 2 or 3 bitten off twig tips on the ground below. On May 2 I found sugar maple twig tips with small leaves and flowers lying on the ground, evidently the work of these squirrels, a number of the small chunky flowers gone from their long stalks, which they were after.

In oak and hickory woodland further east on Long Island (Mastic, L. I., 1921) gray squirrels regularly feed on opening twigs of the oak in similar manner, nibbling at the catkins then dropping the twig. I have record of such operations on the scarlet oak April 27 to 29, seeing the squirrel at work at sunset; and have picked up twigs of a later blooming white oak similarly nibbled May 24 to 29. Here also one was seen feeding on the flowers of a cherry at sunset April 27.

The lavishness, wastefulness of all these feeding habits of the gray squirrel is notable. How different from the tenacity with which an animal of prey, the sparrow hawk, clings to the last vestiges of a mouse it has captured. But this very lavishness has a certain significance. If every nut that was planted were presently dug up and consumed, if seeds were not carried about in times of plenty and then tossed aside, these squirrels would be less helpful agents in spreading the forests on which they depend. Whatever crop they are enjoying at a given time, be it acorns, seeds, buds, is at that particular time far in excess of their needs. It behooves them not so much to conserve their food as to cultivate a varied appetite and wide knowledge of what is good to eat and where to find it, so that failure of any source at any particular time of year or in any particular year will not find them at a loss as to where else to turn for sustenance. —JOHN TREADWELL NICHOLS, *American Museum of Natural History, New York City.*

### SQUIRRELS AS MUSHROOM EATERS

The squirrel may be both a mycologist and a mycophagist, that is, it appears to study mushrooms as well as to eat them. On a large estate, where I passed the summer of 1914, at Greenwich, Connecticut, gray squirrels were as sacred as the white elephant. There was a large stump, sawed off square on top, encased in the south border wall of the lawn, where the gray squirrels gathered to eat mushrooms. When a squirrel had finished a cap, it would hop out on the big lawn, select another cap that suited its taste and return to the top of the stump to eat. One point I wish to make is that the squirrel seems to differentiate between the edible and the poisonous species, apparently never touching the latter. In this matter it is unlike the box tortoise which does not discriminate. In consequence, we find tortoise skeletons in the woods and fields, examination having shown that the animals had devoured the deadly *Amanita phalloides*. Most species of vertebrates, including frogs, snakes, lizards, and domestic stock, eat

mushrooms. At Forked River, New Jersey, I was present when a cow died after eating the deadly *Amanita;* a flock of hens partook freely of *phalloides* and all died. There are but few poisonous species, but of *phalloides* there are vast numbers of caps fruiting the entire period of warm weather. Amphibians and reptiles undoubtedly eat mushrooms because of the worms or maggots in the stems and the slugs, or shelless snails, invariably attached to the stems or gills. As there are no nuts until autumn, the squirrel practically lives on mushrooms all summer, favoring trees on which or around which they grow.—W. H. Ballou, *Closter, New Jersey.*

### NOTES ON PRAIRIE-DOGS

Last fall (1925) an interesting sixty-acre prairie-dog town was observed near Barstow, Texas, in a salt-grass pasture. The water table here normally stands at about 50 inches below the surface and when adjoining fields are irrigated two-thirds of the town is temporarily covered by the run of water when turned into the pasture to irrigate the grass. The prairie-dogs were active several days after the flooding as well as before.

Excavations showed that the depth of the burrows was not over 38 to 42 inches, with a general depth of 24 and 32 inches, depending upon the sand strata, and upon capillary attraction governed by distance from drainage canal. The top of a nest in one system 48 feet long was but 12 inches below the surface of the adobe ground under a clump of salt grass. The nest chamber was bladder-shaped, 14 inches in height and 20 inches deep counting the entry, and was above the sand strata. A domed oval perch 20 inches long, and 22 inches below the surface, was filled to the depth of 3 inches with droppings. Here probably the prairie-dogs perched at times to avoid drowning. Alkali deposits in portions of the burrows at a depth of 26 inches and below showed that the drainage water at times rose through excess seepage above the 50-inch water table.

In September, 1923, great swarms of grasshoppers were observed in the Panhandle section. One of the swarms in passing over and alighting in a prairie-dog town provided a great feast for the animals. The prairie-dog population was out in full force chasing after, catching, and eating the grasshoppers. Numbers of the animals were successful in "fielding" the low flying and dropping grasshoppers as they passed. Some of the prairie-dogs in making the "catches" jumped into the air with that characteristic chirping bark which they sometimes give.—L. C. Whitehead, *San Antonio, Texas.*

### THE INTRODUCTION AND SPREAD OF HOUSE RATS IN THE UNITED STATES

Both species of house rat, the black rat (*Rattus rattus*) and the brown rat (*Rattus norvegicus*), apparently originated in the Orient. The black rat was the first to invade the western world. Barrett-Hamilton and Hinton (The Black or ship rat: A history of British Mammals, part 18, pp. 578–599, February, 1916) state that there can be little doubt that this species was imported into Europe by the navies of the Crusaders. There is no clear evidence of its presence prior to the Crusades of the years 1095, 1147, and 1191, but it was firmly established in western Europe shortly afterwards. The brown rat first made its appearance in Europe at the beginning of the eighteenth century. The same authors (Barrett-

Hamilton and Hinton, 1916, pp. 608–609) cite numerous references to show that this rat migrated in vast hordes across the Volga River in 1727 and gradually spread westward across Russia to the Baltic Sea, arriving in east Prussia about 1750, that its earliest arrival in western Europe by sea was at Copenhagen when the Russian fleet visited that city in 1716, and that its arrival in Norway was about 1768, in Sweden about 1790, in France about 1750, in Switzerland about 1809, in Spain about 1800, in Italy about 1750, and in England about 1728.

The date of the arrival of the black rat in America is not known, although it is certain that it was well established in the English colonies by the beginning of the eighteenth century. Black rats are notorious mariners and few even of modern vessels are free from them, so that since this species was abundant in Europe during the fifteenth century, it is readily conceivable that they may have made their maiden voyage across the Atlantic with Columbus in 1492. It would not necessarily follow, however, that they left the ships and succeeded in establishing a foothold in the New World at that time.

Prior to the introduction of the brown rat, the black rat was abundant throughout the settled portions of the colonies. Today they are almost wholly absent except in the southern parts of our southern states where they are still the predominant species in many sections. They are also to be found in small colonies at practically all our seaport towns, because of the fact that they abound in practically all sea-going vessels. As late as 1900 there were still a few inland colonies of black rats in the New England states and forty years ago black rats predominated in Raleigh, North Carolina.

The brown rat is stated by many authors to have been introduced into the United States, probably from England, about the first year of the American Revolution, 1775. Its arrival on the Pacific coast is said to have occurred about 1850.

From the various seaports into which brown rats have been constantly imported into the United States from all parts of the world, the pests have gradually spread landward until they now (1926) infest every state in the Union. It is a peculiar coincidence, however, that the first record of rats from Montana, the last state or territory of the United States to become infested, was obtained after this article was first written. An investigation by economic mammalogists in 1924 failed to find a single record of the occurrence of house rats in that state. On June 1, 1926, O. E. Stephl, leader of rodent control for the Biological Survey in Montana, wrote that no records had been received at his office, but on August 28 he reported finding a few rats at both Lewistown and Fort Benton. It was learned that the initial infestation at Lewistown took place about three years ago (1923). At Fort Benton it was reported that rats were introduced in the early days before railroads, when freight for mining camps was taken off the boats there. For a time they were quite numerous but later, after the boats stopped, they almost disappeared. It was also stated that at that time rats also gained a foothold in Helena but since have entirely disappeared, suggesting that rats do not thrive well under Montana climatic conditions.

Over much of the United States the house rat followed closely on the heels of the early settlers, but in the high, rocky, dry mountain regions its progress has been relatively slow. With the exception of Montana, Wyoming has been the last state invaded, the first rats apparently crossing the border from Nebraska

about seven years ago (1919), while at the present time they are reported as having worked their way up the Platte River valley as far as Fort Laramie and as being common along much of the Nebraska line. They are also firmly established at Sheridan not far from the Montana line. In 1915, they were abundant in the eastern part of North Dakota but scarce in Dickey and McHenry counties, while it was reported that there were none at all in Medora or Sentinel Buttes, nor in the Black Hills section of South Dakota. At present they are abundant at Minot, North Dakota.

Rats were reported from Denver, Colorado, in 1886 and by 1907 had entrenched themselves in most of the larger towns of the state. In 1888 there were no rats in Utah but in that year they were reported abundant in Albuquerque, New Mexico, and were known to occur in Arizona. It has only been in more recent years that the rat has visited Idaho, although at present it has become a great pest in parts of the state. These and other records indicate the general trend of the house rat in the United States. Their progress has been more rapid in temperate climates although they are abundant in most northern states and are reported common in parts of Alaska, Canada, and Newfoundland.—JAMES SILVER, *U. S. Biological Survey, Washington, D. C.*

### A POSSIBLE ALBINO ARMADILLO

In my reading I have never seen any references to cases of albinism in the nine-banded armadillo. A short time ago, I received a letter from George W. Coryell of Boerne, Kendall County, Texas, in which he refers to a peculiar armadillo which may have been an albino. He says "a white, perhaps albino, armadillo recently escaped from a Mexican near the store. He was unable to recapture it." I wrote for further information and Mr. Coryell asked the Mexican about the animal. He said that it was so different from any other specimen that he had ever seen that he brought it from "San Angel" (San Angelo), 150 miles west of Boerne, in order to exhibit it to his friends. He claimed that it was lighter in color than a newly born baby armadillo. Mr. Coryell, who saw the escaping animal at a distance of probably twenty yards, confirms the Mexican's description. A substantial reward has been offered for the recapture of the odd specimen but to date nothing has come of it. Has any reader of the JOURNAL OF MAMMALOGY ever seen or heard of an albino armadillo?—JOHN K. STRECKER, *Baylor University, Waco, Texas.*

### ALTITUDE LIMIT OF BISON

In the May, 1926, number of the JOURNAL OF MAMMALOGY, Fritiof M. Fryxell gives some interesting notes on the range in altitude of the bison. I have had some opportunities for making observations on this matter in Colorado. In the "Mammals of Colorado" I mentioned that I had found the skull of a bison at nearly 11,000 feet. To be more precise, it was probably 10,700 feet. The locality was near Irwin, Gunnison County, close to the old Venango mine. Nearby was a small lake, surrounded by an open park or meadow. All about this was a heavy Engelmann spruce forest, which, however, began to decrease both in size and density as timberline, in this region about 12,000 feet, was approached. Though I tramped much along a high ridge which extends for several miles above

the place where the skull was found, I never found any remains of bison there, though there were plenty of smooth, grassy slopes which would afford good grazing.

In September, 1914, I was collecting about Alma, Park County. One day I was in Mosquito Gulch, and at a miner's cabin, at 11,500 feet, was a bison skull. The owner told me that it had been picked up in the immediate vicinity. He also said there were a good many scattered about on the hills, which statement was verified by another reliable party. A road goes up Mosquito Gulch and crosses the Park Range by way of Mosquito Pass to the valley of the Arkansas River. This pass has an elevation of 13,185 feet. The mountains about the head of Mosquito Gulch have smooth, comparatively gentle, grass-covered slopes, and I see no reason why the bison should not have ranged at will over them, crossing from one watershed to the other, and have no doubt they did.

There used to be a small herd of bison which ranged about Pikes Peak, in the Seven Lakes and Beaver Creek region. To get from Seven Lakes to Beaver Creek, or vice versa, they had to cross a divide about 12,000 feet high. C. E. Aiken tells me that he has no doubt they ranged above timberline. It is less than forty years ago that the last survivor of this band was killed. Men who had seen these animals told Mr. Aiken that when alarmed they would rush through heavy timber, full of fallen logs, with ease.

I doubt if the bison had much respect for altitude, and I believe that they went as high as they chose. It is evident from what Mr. Fryxell says that they could travel in pretty rough country.

In Colorado bison ranged through the large mountain-valleys or parks, and into the northwestern part of the state,—Routt and Moffatt Counties, in different parts of which I have found skulls. The three northern parks, North, Middle and South, are separated by high mountain ranges, Middle Park being on the Pacific slope of the Continental Divide, the other two on the Atlantic slope. All the passes crossing the divide are high, none under 10,000 feet, most of them 11,000 to 12,000 feet elevation and even more. Therefore the bison, if they wandered from one region to another, as they may have done at times, had to traverse these high passes, or, if they did not use the passes, go even higher over other parts of the mountains. All through the Colorado mountains, at even quite high elevations, are found open valleys and meadows along the streams. Some are small, others of good size, and doubtless all were more or less frequented by bison, at least in summer, even though the animals may have had to move to lower altitudes to avoid the deep snow of winter. Only the pioneers could tell us about this, and most, if not at all of them, have gone, like the bison. —Edward R. Warren, *Roosevelt Wild Life Station, Syracuse, New York, and 1511 Wood Ave., Colorado Springs, Colorado.*

### THE PRONG-HORN ANTELOPE IN ILLINOIS

In the Journal of Mammalogy for November, 1926, on pages 332–334, is a note communicated by F. M. Fryxell of Augustana College, Rock Island, Illinois, regarding the discovery of a horn of the prong-horn antelope in the outskirts of Moline, Illinois. It was found at a depth of eighteen inches in alluvium. The horn was that of a full-sized animal and its surface was hard and

showed no decay. The writer of the note was uncertain as to the origin of the object. He was able to find Indian flints and pottery immediately under the sod and one might infer that the horn was much older.

In this connection it may be recalled that in 1875 (Amer. Jour. Sci., ser. 3, vol. 11, pp. 47–48) Dr. J. A. Allen recognized in a collection of Pleistocene fossils made by J. D. Whitney, in the lead region of Wisconsin, Iowa, and Illinois, a part of a radius which did not differ appreciably from the corresponding part of *Antilocapra americana*. Unfortunately, little care had been taken to record the localities where the fossils of that region were collected; and the writer finds it impossible to determine whether the bone in Allen's hands had been found in Wisconsin, Iowa, or Illinois. However, the region is circumscribed (including Blue Mounds, Wisconsin; Dubuque, Iowa; and Galena, Illinois); and the discovery makes it probable that the bone found at Moline dates back to the late Pleistocene or early Recent.—Oliver P. Hay, *U. S. National Museum, Washington, D. C.*

## AN INTERESTING DEER FROM SZECHWAN

Three species of large deer are described from the province of Szechwan, western China. One of these, a sambar, *Cervus unicolor dejeani* (Pousarges), belongs to the subgenus *Rusa*, the two others to the subgenus *Cervus*, namely *Cervus canadensis wardi* Lydekker and *Cervus cashmirianus macneilli* Lydekker, the latter afterward regarded as a distinct species, *Cervus macneilli*, by Pocock and by Lydekker. Of these two the former is based on two shed antlers which its author later (Cat. Ungulates Brit. Mus., vol. 4, p. 138, 1915) concluded might after all have belonged to *C. macneilli*. The latter is based on the mounted skin of a female. Both types are in the British Museum, and Lydekker in his Catalogue of the Ungulates in that institution corrects the type locality for both to "Sze-chuan border of Tibet," rather than Szechwan province itself. The distinguishing feature of *C. macneilli* is its pale gray tone with the upper side of the tail black, and the whitish of the hind quarters restricted to the back of the hams.

Through the generosity of Dr. Thomas Barbour the Museum of Comparative Zoölogy has lately received the skin and skull of a female deer from Batang, near the Tibetan border of western Szechwan, which in its coloration is clearly neither of the *macneilli* style with black tail, nor of the *wallichi* type with a large pale rump patch. It is a winter specimen with extremely harsh stiff pelage, of a general dull brown (nearly "bistre") above, darkening on the head and neck, the individual hairs with a short terminal band of pale buff producing a minutely ticked appearance on close inspection. The inside of the ears is white as is also the chin, and area between the jaws, extending up to include the upper lip and end of the muzzle. The rump patch is small, but includes a narrow posterior portion of the buttocks, and extends forward to take in the tail and an area about 150 mm. in advance of it, where it is sharply delimited by the dark blackish brown of the croup. In color and pattern the skin is very like Lydekker's figure of *Cervus thoroldi* (in Deer of all Lands, plate 5, 1898), now regarded as synonymous with *C. albirostris*, but lacks the supposed distinguishing mark of this species, the reversal of the coarse hair of the withers "to form a kind of hump." The tips of the hairs on the upper part of the neck medially, do, however, tend to turn forward, and it seems likely, as Pocock has suggested, that this trait is a mark

of old hair, rather than a valid specific character. Moreover, in *C. albirostris* the median area of the tail is described as dark, the whitish or buffy rump patch not forming a complete disk, and Lydekker's figure of *thoroldi* is stated to be incorrect in this respect.

In its skull, the present specimen seems to resemble the Hangul or Kashmir stag, *Cervus hanglu* Wagner, with a broad flattened muzzle, and long nasals that are much expanded proximally in comparison with *C. canadensis*. The larger rump patch, however, without a dividing median line of black seems to distinguish it from *C. hanglu* of which it is possibly an eastern race, and for which the name *wardi* may eventually prove available, if indeed it is really separable from *albirostris* of the Nanshan and Lhasa regions of Tibet.—GLOVER M. ALLEN, *Museum of Comparative Zoology, Cambridge, Massachusetts.*

---

# RECENT LITERATURE

**Audubon, John James.** DELINEATIONS OF AMERICAN SCENERY AND CHARACTER. With an introduction by Francis Hobart Herrick. New York: G. A. Baker and Company. 8vo, pp. xlix + 349, 1 plate. Cloth, $4.50. October, 1926.

This volume consists of fifty-eight episodes relating mainly to events in pioneer life between the years 1808 and 1834, and which were originally incorporated in Audubon's "The Birds of North America." In the introduction, Professor Herrick gives a brief account of Audubon's life and tells us how these stories came to be written. As the title of the book indicates, the sketches portray American character and scenery; but the title does not reveal that they also offer tales of adventure in the wilderness and many interesting observations on natural history, no small portion of which relates to mammals. Individuals may differ in their opinions of Audubon as a naturalist or an artist, but all will agree that in the personal charm of his writings he can hardly be surpassed. These sketches are Audubon at his best.

The book is substantially bound, the typography clear, and the paper of good quality. Typographical errors are few, although we note that the date of the death of Audubon is given as in 1861 (p. xvii), whereas it should read 1851.—HARTLEY H. T. JACKSON.

---

AICHEL, O. Über Zahndurchbruch und Kieferresorption, sowie über das Os sacculi dentis (Aichel). Anat. Anzeiger, vol. 61, pp. 42–43. April 14, 1926.

ALTMANN, FRANZ. Ein Fall von Missbildungen am Genitale, am uropoetischen System und am knöchernen Becken bei einen Alpensteinbock (Capra ibex). Zeitschr. f. Anat. u. Entwicklungsgeschichte, vol. 79, pp. 269–292, illus. July 5, 1926.

——— Ein Fall von Hypogastrius parasiticus bei einer Ralte (Duplicitas asymmetros ventralis infraumbilicus Schwalbe). Zeitschr. f. Anat. u. Entwicklungsgeschichte, vol. 79, pp. 413–432, illus. July 5, 1926.

ASHBROOK, FRANK G., AND FRANK L. EARNSHAW. Fur laws for the season 1926–27. U. S. Dept. Agric., Farmers' bull. no. 1515, pp. 1–28. September, 1926.

AWTOWKRATOW, D. M. Variationen der Verzweigung der Oberschenkelarterie (Arteria femoralis) beim Pferde. Anat. Anzeiger, vol. 61, pp. 34–39. April 14, 1926.

——— Gesetzmässigkeit der Variationen in der Verzweigung der Oberschenkelarterie (A. femoralis) beim Pferde. Anat. Anzeiger, vol. 61, pp. 89–93. April 19, 1926.

BAILEY, VERNON. A reconnaissance of the mammals in the vicinity of Sewickley. The Cardinal [Sewickley, Pennsylvania], no. 8, pp. 1–8, 1 pl. July, 1926.

——— Mammals of the vicinity of Washington. Journ. Washington Acad. Sci., vol. 16, pp. 441–445. October 4, 1926.

BAISS, G. G. Unwary deer. The Field [London], vol. 148, p. 395. August 26, 1926.

BARRETT, S. A. Filming moose on Isle Royale. Milwaukee Public Mus., yearbook, vol. 4, pp. 47–59, illus. October 9, 1926.

BASCOM, K. F. The chronicle of Obadiah. Nat. Mag., vol. 8, pp. 201–204, illus. October, 1926. (Account of woodchuck in captivity.)

BAUM, H. Die Benennung der Lymphknoten. Anat. Anzeiger, vol. 61, pp. 39–42. April 14, 1926.

BAYNES, ERNEST HAROLD. Actaeon—A white-tailed deer. Nat. Mag., vol. 4, pp. 79–83, 124–126, illus. August, 1924.

BIGELOW, HENRY B. Plankton of the offshore waters of the Gulf of Maine. Bull. U. S. Bur. Fisheries, vol. 40, pt. 2, doc. no. 968, 509 pp., 134 figs. 1926. (Includes information concerning the food of whales.)

BOBRINSKOY, N. A. Materials on the bat fauna of Turkestan (Russian Turkestan with the regions of Semiretchie and of Transcaspia, Khiva and Bouchara) [Trans. title]. Bull. Soc. Nat. Moscow, sect. biol., year 1925, new ser., vol. 34, pp. 330–374. 1925. (In Russian, with summary in English. Lists 20 forms, and describes as new: *Myotis emarginatus turcomanicus*.)

——— Preliminary note on the Chiroptera of central Asia [trans. title]. Comptes Rendus Acad. Sci. U. R. S. S., 1926, pp. 95–98. 1926. (In Russian. Describes as new: *Myotis mystacinus przewalskii, Eptesicus nilssoni gobiensis, E. n. centrasiaticus, E. n. kashgaricus, E. caucasicus pallescens, E. alashanicus*, and *Plecotus auritus kozlovi*.)

BOLKAY, ST. J. Preliminary notes on a new mole (*Talpa hercegovinensis* n. sp.) from central Hercegovina and diagnoses of some new mammals from Bosnia and Hercegovina. Novitates Musei Sarajevoensis, no. 1, 16 pp., illus. June 29, 1925. (Describes as new: *T. hercegovinensis, Crocidura leucodon narentae, Ursus arctos bosniensis, Canis lupus kurjak, Microtus arvalis havelkae, M. nivalis malyi, M. minutus mehelyi, Sus attila reiseri, Capreolus capreolus grandis*, and *Rupricapra rupricapra balcanica*.)

BOWER, WARD T. Fur-seal industry. Alaska Fishery and Fur-seal Industries in 1925, Rep. U. S. Comm. Fisheries 1926, appendix 3, Bureau Fish. Doc. no. 1008, pp. 140–160. November, 1926.

BROOKE, H. C. Hairless mice. Journ. Heredity, vol. 17, pp. 173–174, illus. May, 1926.

BROOM, R. On the mammalian presphenoid and mesethmoid bones. Proc. Zool. Soc. London, 1926, pp. 257–264. April 29, 1926.

BROOM, R. On the organ of Jacobson and some other structures in the nose of *Caenolestes*. Proc. Zool. Soc. London, 1926, pp. 419–424, 1 pl. July, 1926.

BURNETT, W. L., AND SAM C. MCCAMPBELL. Jack rabbits of eastern Colorado. State Entomologist, Colorado Agric. College, circ. 52, 18 pp. November, 1926.

CABRERA, A., AND A. E. RUXTON. On mammals from Luluabourg, southern Congo. Ann. and Mag. Nat. Hist., ser. 9, vol. 17, pp. 591–602. May, 1926. (Lists 74 forms, and describes as new: *Mops angolensis niveiventer*, *Nandinia binotata intensa*, *Galagoides demidoffi phasma*, and *Pelomys minor*.)

CARLSSON, ALBERTINA. Über die Tragulidae und ihre Beziehungen zu den übrigen Artiodactyla. Acta Zoologica, vol. 7, pp. 69–100. 1926.

CASTLE, W. E. Heredity in rabbits and guinea-pigs. Bibliographia Genetica ('s-Gravenhage, Martinus Nijhoff), vol. 1, pp. 419–458, illus. 1925.

CHLOPKOW, A. Zur Frage über die Struktur des Herzmuskelsarkolemms der Säugetiere. Anat. Anzieger, vol. 61, pp. 431–442, illus. September 30, 1926.

CLAPHAM, R. The weight of foxes. The Field [London], vol. 168, p. 861. November 11, 1926.

CLARK, SAM L. Nissl granules of primary afferent neurons. Journ. Comp. Neur., vol. 41, pp. 423–452, 1 pl. August 15, 1926. (Work on dogs.)

CLARK, W. E. LE GROS, AND CHARLES F. SONNTAG. A monograph of *Orycteropus afer*—III. The Skull [by Clark]. The skeleton of the trunk and limbs. General summary. [By Sonntag.] Proc. Zool. Soc. London, 1926, pp. 445–485, illus. July, 1926.

COLMAN, JEREMIAH. Sheep and deer fraternising. The Field [London], vol. 148, p. 690. October 14, 1926.

CORDIER, R. Recherches morphologiques et expérimentales sur la cellule chromo-argentaffine de l'epithélium intestinal des vertébres. Archives de Biologie, vol. 36, pp. 427–463, 2 pls. 1926. (Some work on mammals.)

CROZIER, W. J., AND G. PINCTUS. Stereotropism in rats and mice. Journ. Gen. Physiol., vol. 10, pp. 195–203, illus. September 20, 1926. (*Rattus norvegicus* and *Mus musculus*.)

DICE, L. R. The zoological resources of Michigan. The birds and mammals. Michigan Acad. Sci., Arts and Letters, 27–28th Ann. Rep., pp. 74–80. November 15, 1926.

DISSELHORST, R. Zum Aufsatz von Erich Schuntermann: Über kastanienartige Bildungen an den Gliedmassen von Lama huanachus. Anat. Anzeiger, vol. 61, pp. 206–207. June 9, 1926.

DOMINGUEZ, R. Note on arteriosclerosis in rabbits caused by some samples of uranium nitrate. Science, n. s., vol. 64, pp. 407–408. October 22, 1926.

DRAKE-BROCKMAN, R. E. A new subspecies of dik-dik (Madoqua). Ann. and Mag. Nat. Hist., ser. 9, vol. 18, pp. 212–214. August, 1926. (Describes as new: *M. phillipsi lawrancei*.)

DYMOND, J. R. The wapiti in Ontario. Canadian Field-Nat., vol. 40, p. 140. October 8, 1926.

EALES, NELLIE B. Einige Anmerkungen über die Monographie von Boas und Pauli, "The Elephant's Head," Pt. 2. Anat. Anzeiger, vol. 61, pp. 361–364. August 14, 1926.

ERNST, M. Über Untergang von Zellen während der normalen Entwicklung bei Wirbeltieren. Zeitschr. f. Anat. Entwicklungsgeschichte, vol. 79, pp. 228–262, illus. May 5, 1926.

——— Vergleichende Untersuchungen über die Urnierensekretion. Zeitschr. f. Anat. u. Entwicklungsgeschichte, vol. 79, pp. 781–796, illus. September 30, 1926. (Partly on mammals.)

FABIAN, H. Beitrag zu dem Problem der überzähligen Wangenhöcker. Anat. Anzeiger, vol. 61, pp. 209–224. July, 1926. (Refers to mammalian teeth.)

FINLEY, WILLIAM L. AND IRENE. Trailing a cougar to get his photograph. Nat. Mag., vol. 4, pp. 69–72, illus. August, 1924.

——— ——— The gentle wood-pussy. Nat. Mag., vol. 4, pp. 141–142, 186, illus. September, 1924. (Habits of skunk.)

——— Lions of the sea. Nat. Mag., vol. 4, pp. 203–207, 256, illus. October, 1924. (Popular account of sea-lions.)

——— Billy, the badger. Nat. Mag., vol. 4, pp. 284–288, illus. November, 1924.

——— Mammals of the mountain-tops. Scribner's Mag., vol. 80, pp. 433–439. October, 1926.

FOX, CARROLL, AND E. C. SULLIVAN. A comparative study of rat-flea data for several seaports of the United States. U. S. Public Health Service, reprint no. 1039 from Public Health Reps., September 11, 1925, pp. 1909–1934, 28 pp., 16 charts. 1925.

FREEMAN, O. W. Mammoth found in loess of Washington. Science, n. s., vol. 64, p. 477. November 12, 1926.

GABINSKY, A. M. Zur Frage über die topographische Lage und Ausbreitung des "Truncus collateralis" und des "Ganglion supremum Thoraci" bei Hunden und Katzen. Anat. Anzeiger, vol. 61, pp. 225–235, illus. July 1, 1926.

GATES, WILLIAM H. Symbols for mutations in mice. Science, n. s., vol. 64, p. 328. October 1, 1926.

GERMAIN, L. La vie des animaux à la surface des continents. Pp. iii + 260, maps. Paris: Felix Alcau. 1924.

GLASER, W. Die intramurale Innervation der Kranzgefässe. Zeitschr. f. Anat. u. Entwicklungsgeschichte, vol. 79, pp. 797–804, illus. September 30, 1926. (On various mammals.)

GOODWIN, H. A. C. Sheep fraternizing with deer. The Field [London], vol. 148, p. 543. September 23, 1926.

GOULD, HARLEY N. On the vestibular labyrinth of the albino rat after prolonged rotation. Journ. Comp. Anat., vol. 41, pp. 223–252, illus. August 15, 1926.

GRAY, LLOYD P. Some experimental evidence on the connection of the vestibular mechanism in the cat. Journ. Comp. Neur., vol. 41, pp. 319–364, 4 pls. August 15, 1926.

GREEN, MORRIS M. Notes on some Saskatchewan voles. Canadian Field-Nat., vol. 40, pp. 142–143. October 8, 1926.

GREGORY, WILLIAM K. The horse in the tiger's skin. Zool. Soc. Bull., vol. 29, no. 4, pp. 111–133, illus. July–August, 1926. (Account of zebras.)

HALL, EDWARD. My meerkat. The Field [London], vol. 148, p. 395. August 26, 1926.

HALL, E. RAYMOND. Economic value of the Mexican free-tailed bat. California Fish and Game, vol. 12, pp. 135–137. July, 1926. (Review of four recent publications on the subject.)

——— Barbed wire fence causes death of deer. California Fish and Game, vol. 12, pp. 151–152. July, 1926.

——— Forage habits of pocket gopher. California Fish and Game, vol. 12, p. 152. July, 1926. (Note on *Thomomys b. bottae*.)

——— New method of predatory mammal control. California Fish and Game, vol. 12, p. 154. July, 1926.

——— Systematic notes on the subspecies of Bassariscus astutus with description of one new form from California. Univ. California Publ. Zool., vol. 30, no. 3, pp. 39–50, pls. 2–3. September 8, 1926. (Describes as new: *B. a. octavus*.)

——— The muscular anatomy of three mustelid mammals, Mephitis, Spilogale, and Martes. Univ. California Publ. Zool., vol. 30, no. 2, pp. 7–38, illus. September 14, 1926.

HAMMETT, FREDERICK S. Studies of the thyroid apparatus. XXXI. The rôle of the thyroid and parathyroid glands in the growth of the central nervous system. Journ. Comp. Neur., vol. 41, pp. 171–204, 6 charts. August 15, 1926. (Work on rats.)

——— Studies on the thyroid apparatus. XXXII. The rôle of the thyroid apparatus in the solids-water differentiation of the central nervous system during growth. Journ. Comp. Neur., vol. 41, pp. 205–222, 3 charts. August 15, 1926. (Work on rats.)

HAMMOND, JOHN. Reproduction in the rabbit; with foreword and chapter on the formation of the corpus luteum by F. H. A. Marshall. Edinburgh and London: Oliver and Boyd. Biological monographs and manuals, no. IV, xxv + 210 pp., 20 pls. 1925.

HARGITT, GEORGE T. The formation of the sex glands and germ cells of mammals. II. The history of the male germ cell in the albino rat. Journ. Morph. and Physiol., vol. 42, pp. 253–306, 5 pls. June 5, 1926.

HARRIS, KILROY. The Australian koala. Nat. Mag., vol. 4, p. 176. September, 1924.

HARTMAN, CARL. Inheritance of accessory mammae. Science, n. s., vol. 64, p. 249. September 10, 1926.

HATT, ROBERT TORRENS. A new dorsal gland in the ground-squirrel, Callospermophilus, with a note on its anal gland. Journ. Morph. and Physiol., vol. 42, pp. 441–451, illus. September 5, 1926.

HAY, OLIVER P. Professor Osborn on the mammals and the birds of the California tar pools. Science, n. s., vol. 64, pp. 426–427. October 29, 1926.

HILL, HOWARD R. A whale for the Los Angeles Museum. Museum Graphic [Los Angeles Museum], vol. 1, no. 2, pp. 64–66, illus. November, 1926. (Finback whale from off coast of Humboldt County, California.)

HILL, W. C. OSMAN. A comparative study of the pancreas. Proc. Zool. Soc. London, 1926, pp. 581–631, illus. July, 1926.

HINTON, MARTIN A. C. Note on the occurrence of a vole in northern Africa. Ann. and Mag. Nat. Hist., ser. 9, vol. 18, pp. 304–306. September, 1926. (New species: *Microtus mustersi*.)

HOPWOOD, ARTHUR T. Some Mammalia from the Pliocene of Homa Mountain, Victoria Nyanza. Ann. and Mag. Nat. Hist., ser. 9, vol. 18, pp. 266–272. September, 1926. (Describes *Metridiochoerus andrewsi* gen. and sp. n.)

HORNADAY, WILLIAM T. Saving the big game of Mexico. Nat. Mag., vol. 4, pp. 213–219, 236, illus. October, 1924.

HOWELL, A. BRAZIER. Voles of the genus Phenacomys. I. Revision of the genus Phenacomys. II. Life history of the red tree mouse (Phenacomys longicaudus). North Amer. Fauna no. 48, pp. IV + 66, pls. 1–7. October 12, 1926.

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE. Opinions rendered by the International Commission on Zoological Nomenclature. Opinions 91 to 97. Smithsonian Misc. Coll., vol. 73, no. 4, pp. 1–30. October 8, 1926.

JOHNSTON, EDWARD C. Fur-seal census, Pribilof Islands, 1925. Alaska Fishery and Fur-seal Industries in 1925, Rep. U. S. Comm. Fisheries 1926, appendix 3, Bureau Fish. Doc. no. 1008, pp. 161–166. November, 1926.

KENT, C. C. Field notes on the Mfolozi Game Reserve. South African Journ. Nat. Hist., vol. 6, pp. 38–48. June, 1926.

KLOSS, C. BODEN. A new race of monkey from Annam. Ann. and Mag. Nat. Hist., ser. 9, vol. 18, p. 214. August, 1926. (Describes as new: *Presbytis nemaeus moi*.)

KOHN, A. Über den Bau des embryonalen Pferdeeierstocks. (Ein Beitrag zur Kenntniss der Zurschenzellen.) Zeitschr. f. Anat. u. Entwicklungsgeschichte, vol. 79, pp. 366–390, illus. July 5, 1926.

KOLMER, W. Über Chordaverdoppelung bei einem jungen Katzenembryo. Zeitschr. f. Anat. u. Entwicklungsgeschichte, vol. 79, pp. 805–807, illus. September 30, 1926.

KOSTILEW, N. Acanthocephalen des Hauskatze und des Haushunds. Zool. Anzeiger, vol. 68, pp. 263–269, illus. October 5, 1926.

KUIPER, K. On the actual existence of leporides. Genetica, vol. 7, pp. 471–474. 1926. (Refers to hare-rabbit crosses.)

———— On a black variety of the Malay tapir (*Tapirus indicus*). Proc. Zool. Soc. London, 1926, pp. 425–426, 1 pl. July, 1926.

LACOSTE, A., AND A. BANDRIMONT. Structure des artères pulmonaires du dauphin (*Delphinus delphis*). Comptes Rendus des Séances de la Soc. Biol. et de ses filiales, Paris, vol. 94, pp. 1148–1150. May, 1926.

LAEYENDECKER, J. Basalplatte und Kopfchorda bei Ovies aries. Anat. Anzeiger, vol. 61, pp. 369–387, illus. September 2, 1926.

LANDAUER, W. Die Vererbung von Haar- und Hautmerkmalen, auschliesslich Färbung und Zeichnung, mit Berücksichtigung von Rassedifferenzierung und Deszendenz. Zeitschr. f. induktive Abstammungs- und Vererbungslehre, vol. 42, pp. 113–226. 1926.

LASHLEY, K. S. Studies of cerebral function in learning. VII. The relation between cerebral mass, learning and retention. Journ. Comp. Neur., vol. 41, pp. 1–58, illus. August 15, 1926. (Work on rats.)

LATCHAM, RICARDO E. Los animales domésticos de la América precolombiana. Publ. Mus. Etnol. y Antrop. de Chile, vol. 3, pp. 1–199. 1922. (Brings together many interesting records from the early Spanish historians.)

LIPPINCOTT, JOSEPH W. Why the 'possum thrives. Nat. Mag., vol. 4, pp. 273–277, 319, illus. November, 1924.

LOGAN, SIDNEY M. Unnecessary destruction of beaver. The Big Horn [Missoula, Montana], vol. 3, no. 3, pp. 3 and 5, illus. August, 1926.

LÖNNBERG, EINAR. On a new fossil porcupine from Honan with some remarks about the development of the Hystricidae. Palaeontologia Sinica, series C, vol. 1, fasc. 3, 15 pp., 1 pl. 1924. (New species: *Hystrix* (*Acanthion*) *lagrelii*.)

LOOMIS, F. B. Leptauchenia and Cyclopidius. Amer. Journ. Sci., vol. 9, pp. 241–249, illus. March, 1925.

LOTSY, J. P. Einiges über die Corriedale-Schafe Neu Seelands. (Schluss.) Genetica, vol. 7, pp. 475–486. 1926.

LUSH, JAY L. Inheritance of horns, wattles, and color in grade Toggenburg goats. Journ. Heredity, vol. 17, no. 3, pp. 73–91, illus. March, 1926.

MANN, W. M. Report of the superintendent of the National Zoological Park for the year ended June 30, 1925. Ann. Rep. Smithsonian Inst., 1925, appendix 6, pp. 87–100. 1926.

MASON, KARL E. Testicular degeneration in albino rats fed a purified food ration. Journ. Exp. Zool., vol. 45, pp. 159–229, illus. May 5, 1926.

MASUI, KIYOSHI. The spermatogenesis of domestic mammals. III. The spermatogenesis of the mouse and of the rabbit. Journ. College Agric., Imperial Univ. Tokyo, vol. 8, pp. 207–252, pls. 4–10. March 30, 1923.

MASUI, KIYOSHI, AND YASUSHIGE TAMURA. The effect of gonadectomy on the structure of the suprarenal gland of mice, with reference to functional relation between this gland and the sex gland of the female. Journ. College Agric., Imperial Univ. Tokyo, vol. 7, no. 4, pp. 353–376, pls. 25–28. May 25, 1926.

MATSUMOTO, H. Contribution to the knowledge of the fossil Hyracoidea of the Fayûm, Egypt, with description of several new species. Bull. Amer. Mus. Nat. Hist., vol. 56, art. 4, pp. 253–350, illus. December 1, 1926. (New families: Geniohyidae, Titanohyracidae, and Pliohyracidae; new species: *Geniohyus gigas*, *G. subgigas*, *G. diphicus*, *Bunohyrax affinis*, *Saghatherium macrodon*, *S. eurydon*, *S. annectans*, and *S. sobrina*.)

MATTHEW, W. D. Correlation of the tertiary formations of the Great Plains. Bull. Geol. Soc. Amer., vol. 35, pp. 743–754. December 30, 1924.

MAURER, F. Carl Gegenbaur. Rede zum Gedächtniss seines 100-Geburtsjahres. Jenaische Zeitschr. f. Naturwissenschaft, vol. 62, pp. 501–518, 2 portraits. September 10, 1926.

MIJSBERG, W. A. Die Morphogenie der Wirbeldomen der Säuger. im besonderen des Menschen. Zeitschr. f. Anat. u. Entwicklungsgeschichte, vol. 79, pp. 112–175, illus. May 5, 1926.

MILLAIS, JOHN G. The southern movement of the wild cat in Scotland. The Field [London], vol. 148, p. 763. October 28, 1926.

MOFFITT, JAMES. Suggested dates of open season on deer in California. California Fish and Game, vol. 12, pp. 124–127, illus. July, 1926.

MOHR, O. L. Über Letalfaktoren, mit Berücksichtigung ihres Verhaltens bei Haustieren und Menschen. Zeitschr. f. induktive Abstammungs- und Vererbungslehre, vol. 41, pp. 59–109, illus. 1926.

NELLMAN, H., AND W. TRENDELENBURG. Ein Beitrag zur Intelligenzprüfung niederer Affen. Zeitschr. f. vergleichende Physiol., vol. 4, pp. 142–200, illus. July 31, 1926.

NELSON, EDWARD W. Report of Chief of Bureau of Biological Survey. 20 pp., U. S. Dept. Agric. December 1, 1926.

NEMILOFF, A. Histo-physiologische Untersuchungen über den Nebenhoden. Zeitschr. f. Anat. u. Entwicklungsgeschichte, vol. 79, pp. 1–43, illus. May 5, 1926. (Work on dog, cat, mouse, rabbit, horse and bull.)

NOPESA, FRANCIS. Heredity and evolution. Proc. Zool. Soc. London, 1926, pp. 633–665, illus. July, 1926.

OSBORN, H. F., AND W. D. MATTHEW. Summary of discoveries in vertebrate paleontology in three seasons of field explorations in Mongolia (1922, 1923, and 1925). Abstract. Bull. Geol. Soc. Amer., vol. 37, pp. 157–158. March, 1926.

OTTO, MAX. In Kanadas Urwäldern und Prärien. 327 pp., illus. Berlin: Paul Parey. 1926. (Accounts of mammals, particularly the wapiti, bear and wolf.)

PAINTER, THEOPHILUS S. The chromosomes of rodents. Science, n. s., vol. 64, p. 336. October 1, 1926.

PALMER, LAWRENCE J. Progress of reindeer grazing investigations in Alaska. U. S. Dept. Agric., Dept. bull. no. 1423, 36 pp., 18 pls. 1926.

PAPEZ, JAMES W. Reticulo-spinal tracts in the cat. Marchi method. Journ. Comp. Neur., vol. 41, pp. 365–400, illus. August 15, 1926.

PARISI, BRUNO. Sulla Capra walie Rüppel. Atti della Soc. Ital. di Sci. Nat., vol. 64, pp. 110–118, pl. 3. 1925.

PARKES, WILLIAM A. Buried Indian workshop with remains of extinct mammal. Bull. Geol. Soc. Amer., vol. 36, pp. 429–434. June, 1925. (Describes *Neomeryx finni* gen. and sp. n.)

PIRA, ADOLF. On bone deposits in the cave "Stora Förvar" on the isle of Stora Karlsö, Sweden. Acta Zoologica, vol. 7, pp. 123–217, illus. 1926. (Treats of seals, dogs, goats, sheep, and oxen.)

POCOCK, R. I. The external character of an adult female Chinese pangolin (*Manis pentadactyla*) exhibited in the society's gardens. Proc. Zool. Soc. London, 1926, pp. 213–220, illus. April 29, 1926.

——— The external characters of a young female *Dinomys branickii* exhibited in the society's gardens. Proc. Zool. Soc. London, 1926, pp. 212–230, illus. April 29, 1926.

——— The external characters of the Jamaican hutia (*Capromys brownii*). Proc. Zool. Soc. London, 1926, pp. 413–418, illus. July, 1926.

——— The external characters of the flying lemur (*Galeopterus temminckii*). Proc. Zool. Soc. London, 1926, pp. 429–444, illus. July, 1926.

——— Pine marten in Yorkshire. The Field [London], vol. 148, p. 594. September 30, 1926.

——— Variation of the pattern in leopards. The Field [London], vol. 148, p. 707. October 21, 1926.

POLLAK, W. Über Kristalloide in Eizellen von Macacus rhesus. Anat. Anzeiger, vol. 61, pp. 202–204, illus. June 9, 1926.

POWELL-COTTON, P. H. G. Races of African elephant. The Field [London], vol. 148, p. 763. October 28, 1926.

PREBLE, EDWARD A. The great anteater. Nat. Mag., vol. 4, p. 158, illus. September, 1924.

——— Caribou of the arctic. Nat. Mag., vol. 8, pp. 218–222, illus. October, 1926.

——— Two-toed sloth. Nat. Mag., vol. 4, pp. 354, 382, illus. December, 1924.

PUCKLE, P. C. Albino badgers. The Field [London], vol. 148, p. 763. October 28, 1926.

RAWITZ, B. Zur Kenntniss der Architektonik der Grosshirnrinde des Menschen und einiger Saugetiere. II. Die Hirnrinde von Orang, Rhesus, Lemur, Kaninchen und Hund. Zeitschr. f. Anat. u. Entwicklungsgeschichte, vol. 79, pp. 198–227, illus. May 5, 1926.

ROBERTS, AUSTIN. Some new S. African mammals and some changes in nomenclature. Ann. Transvaal Mus., vol. 11, pt. 4, pp. 245–263. September 14, 1926. (New genera: *Neoromicia*, type *Eptesicus zuluensis* Roberts; *Eptesicops*, type *V. rusticus* Tomes; *Microfelis*, type *Felis nigripes* Burch. New species and subspecies: *Chaerophon pumilus elphicki, Aonyx capensis coombsi, Poecilogale albinucha transvaalensis, Lynx caracal roothi, L. c. limpopoensis, L. c. damarensis, Leptailurus capensis limpopoensis, Herpestes caffer sabiensis, Parazerus cepapi auriventris, Tatera breyeri, Leggada orangiae, L. deserti valschensis, L. d. pretoriae, Acomys transvaalensis, Cricetomys gambianus haagneri, Aethomys chrysophilus magalakuini, A. c. capricornis, Praomys namaquensis capensis, P. n. klaverensis, P. n. drakensbergi, P. n. lehochloides, Rhabdomys pumilio namibensis, Mastomys concha bradfieldi, M. c. ovamboensis, M. c. komatiensis, Cryptomys orangiae, C. vetensis, C. montanus, C. melanoticus, C. junodi, Bathyergus suillus intermedius, Pedetes caffer damarensis, Pronolagus randensis capricornis, Lepus zuluensis damarensis, Sylvicapra grimmi bradfieldi, S. g. transvaalensis*, and *S. altifrons noomei*.)

ROWLEY, JOHN. The proposed African mammal hall for Los Angeles Museum. Museum Graphic [Los Angeles Museum], vol. 1, no. 2, pp. 43–50, illus. November, 1926.

RUTHVEN, ALEXANDER G. Report of the director of the Museum of Zoology to the Board of Regents, July 1, 1925, to June 30, 1926. Univ. Michigan bull., n. s., vol. 28, no. 10, 51 pp., 1 pl. September 4, 1926.

RUXTON, A. E. Description of a new subspecies of hartebeeste (Bubalis). Ann. and Mag. Nat. Hist., ser. 9, vol. 18, p. 215. August, 1926. (New subspecies: *B. cokei ritchiei*.)

——— On mammals collected by Captain C. R. S. Pitman, Game Warden, Entebbe, Uganda. Ann. and Mag. Nat. Hist., ser. 9, vol. 18, pp. 28–33. July, 1926. (Lists 49 forms and describes as new: *Ourebia pitmani*.)

SADOVNIKOVA-KOLTZOVA, MARY P. Genetic analysis of temperament of rats. Journ. Exp. Zool., vol. 45, pp. 301–318, illus. May 5, 1926.

SAWYER, EDMUND J. Yellowstone nature notes. Parks and Recreation, vol. 10, pp. 70–74. October, 1926. (Notes on mammals.)

SCHAUDER, WILLIAM. Über Entwicklung und Rückbildung des Musculus pronator quadratus des Pferdes. Anat. Anzeiger, vol. 61, pp. 302–310, illus. July 23, 1926.

SCHULTZ, ADOLPH H. Variations in man and their evolutionary significance. Amer. Nat., vol. 60, pp. 297–323. July–August, 1926.

SCHULTZ, ADOLPH H. Fetal growth of man and other primates. Quart. Rev. Biol., vol. 1, pp. 465–521, illus. October (November), 1926.

SCHWARZ, ERNST. Die Meerkatzen der *Cercopithecus aethiops* Gruppe. Zeitschr. f. Säugetierkunde, vol. 1, pt. 1, pp. 28–47, pl. 1 (map). August 31, 1926. (New subspecies: *C. a. nesiotes* and *C. a. excubitor*.)

SCOTT, H. HAROLD. Report on the deaths occurring in the society's gardens during the year 1925. Proc. Zool. Soc. London, 1926, pp. 231–244. April 29, 1926.

SCOTT, W. B. Geological climates. Bull. Geol. Soc. Amer., vol. 37, pp. 261–278. March, 1926.

SIMPSON, G. G. Pre-Cretaceous evolution of mammalian lower molars. Abstract. Bull. Geol. Soc. Amer., vol. 37, p. 238. March, 1926.

SINCLAIR, WILLIAM J. The mounted skeleton of a new Mesohippus from the Protoceras Beds. Proc. Amer. Philos. Soc., vol. 64, pp. 55-63, illus. 1925.

SMITH, FLOYD TANGIER. The Fukien Scientific Expedition. China Journ. Sci. and Arts, vol. 5, pp. 128–131, 5 pls. September, 1926.

SONNTAG, CHARLES F. (See Clark, W. E. Le Gros, and Charles F. Sonntag.)

SOWERBY, A. DEC. Thorold's deer. China Journ. Sci. and Arts, vol. 5, p. 155. September, 1926.

STODDARD, HERBERT L. Report on cooperative quail investigation: 1925–1926. 62 pp., 5 pls. November 2, 1926. (Relation of mammals to quail, pp. 32–37.)

STRECKER, JOHN K. The mammals of McLennan County, Texas. Second paper; supplementary notes. Contr. Baylor Univ. Mus. [Waco, Texas], no. 9, 15 pp. October 15, 1926.

STRONG, L. C. A genetic study of the growth of a transplantable tumor (adenocarcinoma). Journ. Exp. Zool., vol. 45, pp. 231–253, illus. May 5, 1926. (Work on mice.)

SWARTH, HARRY S. Report on a collection of birds and mammals from the Atlin region, northern British Columbia. Univ. California Publ. Zool., no. 4, pp. 51–162, pls. 4–8. September 24, 1926. (Lists 21 species of mammals, pp. 145–151.)

TANNER, C. Die Entwicklung des ackerknechtschen Organs beim Schaf. Anat. Anzeiger, vol. 61, pp. 289–302, illus. July 23, 1926.

THOMAS, OLDFIELD. On mammals from Ovamboland and the Cunene River, obtained during Capt. Shortridge's third Percy Sladen and Kaffrarian Expedition into south-west Africa. Proc. Zool. Soc. London, 1926, pp. 285–312. April 29, 1926. (Describes as new: *Cercopithecus pygerythrus helvescens, Pipistrellus fouriei, Chaerephon (Lophomops) shortridgei, Felis ochreata xanthella, Herpestes cauui swalius, Helogale brunetta, Mungos mungo grisonax, Thos mesomelas achrotes, Paraxerus cepapi phalaena, Funisciurus congicus oenone, Taterona joanae, Dendromus (Poemys) concinnus, Steatomys swalius, S. s. umbratus, Malacothrix egeria, Petromyscus shortridgei, Thallomys leuconoe, T. herero, Aethomys namquensis siccatus, Petromys cunealis, Lepus capensis herero, L. c. narranus, L. c. mandatus*, and *Antidorcas angolensis hofmeyri*.)

——— Two new flying squirrels from Mergui Archipelago. Journ. Bombay Nat. Hist. Soc., vol. 31, p. 22. May 15, 1926. (New subspecies: *Petaurista mergulus reguli* and *P. m. primrosei*.)

THOMAS, OLDFIELD. The Spedan Lewis South American Exploration.—III. On mammals collected by Sr. Budin in the Province of Tucuman. Ann. and Mag. Nat. Hist., ser. 9, vol. 17, pp. 602–609. May, 1926. (Lists 21 forms and describes as new: *Ctenomys viperinus* and *Cavia tschudii sodalis*.)

——— A new Myotis from Ladak. Ann. and Mag. Nat. Hist., ser. 9, vol. 17, pp. 609–610. May, 1926. (New species: *M. meinertzhageni*.)

——— The Godman-Thomas Expedition to Peru.—II. On mammals collected by Mr. R. W. Hendee in north Peru between Pacasmayo and Chachapoyas. Ann. and Mag. Nat. Hist., ser. 9, vol. 17, pp. 610–616. May, 1926. (New subspecies: *Thomasomys ischyrus eleusis*.)

——— The Godman-Thomas Expedition to Peru.—III. On mammals collected by Mr. R. W. Hendee in the Chachapoyas region of north Peru. Ann. and Mag. Nat. Hist., ser. 9, vol. 18, pp. 156–167. July, 1926. (Describes as new: *Vampyressa melissa, Rhipidomys modicus, Proechimys hendeei, P. rattinus* and *Cavia tschudii stolida*.)

——— The Spedan Lewis South American Exploration.—IV. List of mammals obtained by Sir Budin on the boundary between Jujuy and Bolivia. Ann. and Mag. Nat. Hist., ser. 9, vol. 18, pp. 193–195. August, 1926.

——— A new long-eared bat from central Asia. Ann. and Mag. Nat. Hist., ser. 9, vol. 18, pp. 306–307. September, 1926. (Describes as new: *Plecotus mordax*.)

——— Two new Australian Muridae. Ann. and Mag. Nat. Hist., ser. 9, vol. 18, pp. 308–310. September, 1926. (Describes as new: *Rattus glaverti* and *R. youngi*.)

THOMAS, OLDFIELD, AND MISS J. ST. LEGER. The Godman-Thomas Expedition to Peru. –IV. On mammals collected by Mr. R. W. Hendee north of Chachapoyas, Province of Amazonas, north Peru. Ann. and Mag. Nat. Hist., ser. 9, vol. 18, pp. 345–349. October, 1926. (Lists 16 forms and describes as new: *Thomasomys rosalinda* and *Mesomys leniceps*.)

THRONE, ALVIN L. Silent teeth that tell a tale. Milwaukee Public Mus., yearbook, vol. 4, pp. 147–149, illus. October 9, 1926. (Overgrowth of woodchuck incisors.)

TRETJAKOFF, D. Das epidurale Fettgewebe Zeitschr. f. Anat. u. Entwicklungsgeschichte, vol. 79, pp. 100–111, illus. May 5, 1926. (Work on man, horse, cow, pig, sheep, dog, cat and rabbit.)

VAN GELDEREN, J. J. Einige Mitteilungen über das Achselhöhlenorgan des Chimpanse. Anat. Anzeiger, vol. 61, pp. 407–409. September 2, 1926.

VIERHELLER, GEORGE P. Ninth annual report zoological board of control and officers of the St. Louis Zoological Park, April, 1925 to April, 1926. Annual Rep. Div. Parks and Recreation, Dept. Publ. Welfare, St. Louis, for year 1926, pp. 48–64. November, 1926.

VINOGRADOV, B. S. Some external and osteological characters of Prometheomys schaposchnikovi Satunin. Proc. Zool. Soc. London, 1926, pp. 401–411, 4 pls. July, 1926.

WALLENBERG, A. Beiträge zur Kenntniss des Iltisgehirns. Zeitschr. f. Anat. u. Entwicklungsgeschichte, vol. 79, pp. 352–365, illus. July 5, 1926.

WARREN, EDWARD R. Beaver in the Pikes Peak region. Trail and Timberline [The Colorado Mountain Club, Denver, Colorado], no. 98, pp. 4–6. November, 1926.

WEIDENREICH, F. Über den Schmelz der Wirbeltiere und seine Beziehungen zum Zahnbein. (Knochenstudien, Vter Teil.) Zeitschr. f. Anat. u. Entwicklungsgeschichte, vol. 79, pp. 292–351, illus. July 5, 1926.

WEINGOLD, H. Ein Ur (Bos primigenius) auf Helgoland gefunden. Centralblatt f. Min., etc., 1925, Abt. B, no. 1, p. 27. 1926.

WINDLE, WILLIAM F. The distribution and probable significance of unmyelinated nerve fibers in the trigeminal nerve of the cat. Journ. Comp. Neur., vol. 41, pp. 453–477, illus. August 15, 1926.

WOOD, H. E., 2ND. Some early Tertiary rhinoceroses and hyracodonts. Abstract. Bull. Geol. Soc. Amer., vol. 37, pp. 238–239. March, 1926.

ZUKOWSKY, LUDWIG. Der Mandrill von Fernando Po. Archiv. f. Naturgeschichte, vol. 91, pp. 132–136, illus. July, 1926.

——— Elephant seals at Stellingen. The Field [London], vol. 148, p. 633. October 7, 1926.

## CORRESPONDENCE

### AFRICAN GAME PROTECTION

The following extracts are from a letter dated September 9, 1926, at Nairobi, Kenya, to Henry R. Carey of Philadelphia, and signed by Capt. Keith Caldwell.

"Dear Mr. Carey:

I should like to say at once that in my opinion your suggested permanent committee [of the League of Nations] is the one and only possible method of really saving the game of Africa. I had been turning a similar proposal over in my mind for some time. Your proposal goes further into detail and is eminently workable. Your article [Saving the Animal Life of Africa—A New Method and a Last Chance] in the May, 1926, number of the Journal of Mammalogy is very sound.

"The pact of London (1900) was not ratified and the 1914 conference came to an end owing to the war. Neither of these went to the root of the matter. They made various rules (full of loopholes) telling nations how to manage their domestic affairs, but left untouched the greatest of all questions, *the trade in game trophies*. As you say in your article, 'of what use to protect our migratory birds [in the U. S.] when they are slaughtered just over the border in Mexico?' . . . . It is exactly the same as regards [African] game. Not only does game migrate but as we know to our cost, so also do their trophies, especially rhino horn and ivory! These animals would never be killed except for their commercial value.

"When I was in a province of the Belgian Congo last year, every tiny trader had a quantity of white rhino horns [for the export trade]. In conversation with Monsieur ————, the Commissaire of the Province, I drew his attention to this. He agreed it was lamentable, but pointed out that if the Belgian government forbade the export of horns, they would all go over the border to the French Congo. The world's oldest animal destroyed to make an aphrodisiac for the Chinese!

"I think a permanent [League] bureau charged with the protection of African fauna an eminently practical idea. It would require to strive to get certain broad principles agreed upon and, having done so, see that they were carried out. I suggest that *one or at most two travelling observers are all that are required.* Whoever is selected should be a practical as well as theoretical expert in African game preservation. With the modern facilities for travel, a man who knows what to look for can cover a great deal of country in six or eight months; he can weigh up the conditions in different countries, and is thus competent to draw adequate comparisons and to put his finger on the real weak spots and leakages.

"I suggest that, if the League would consider taking the matter up, the first step should be to appoint an observer. His report should be put before the League and could form a basis on which policy could be formulated.

"I am more interested than I can say in this subject and I should be most grateful if you would let me know if anything further transpires."

## RELATION OF ANIMALS TO WEATHER AND CLIMATE

*To the Editor, Journal of Mammalogy:*

At the meeting of the North Central States Entomologists at Urbana, Illinois, March 5, 1926, Dr. Victor E. Shelford proposed an endowed laboratory for the study of the relations of insects and other animals to weather and climate. The grave need for continuous pure science study of this subject was stressed. The proposal was endorsed by the entomologists and a committee appointed to communicate the proposal to the board of trustees of the National Research Endowment, the officers of the National Academy of Sciences, and the National Research Council.

Dr. Shelford's proposal is appropriate and it is hoped the means may be made available to carry it out. In addition to insects it is of course highly desirable, if such a laboratory is organized, that it should give attention to animals generally. Mammals, birds, amphibians, reptiles and fishes have so many direct and indirect relationships to insects that attention to these forms is justified even from the standpoint of economic entomology.

Many data of mammalian life histories should be collected. For example, the dates of migration of bats, time of breeding and molt of mammals generally, dates of hibernation and estivation of rodents and other mammals, period of seed gathering and caching by squirrels, cutting of hay by pikas and aplodontias, and the seasonal activities of the beaver. Phenological studies have taken all too little account of these and similar phenomena. Collection of many data in this field could probably be arranged for with little extra expense. The question of numbers of particular species of mammals at different seasons of the same year, or at the same season in different years, should also come within the scope of such an institution. The importance of reading and interpreting the periodical fluctuations continually occurring in the populations of many mammals has recently been demonstrated by Elton (Brit. Journ. Exper. Biol., vol. 2, pp. 119–163, 1924).

The fundamental interrelationships between animals and plants suggest that the work on the relation of *animals* to weather and climate should be closely correlated with that with *plants*. In order to be most effective the studies should be organized on a bio-ecological basis.

Continuous observations for several years would be necessary to furnish an adequate basis for preliminary conclusions. The terms of organization of the laboratory should by all means provide for its continuance for a long time.

WALTER P. TAYLOR.

Tucson, Arizona,
November 20, 1926.

AUTHORS' SEPARATES

*Editor, Journal of Mammalogy:*

Shall we send authors' separates of articles published in the Journal of Mammalogy to members of the Society? How many members, who keep a file of the Journal, desire and use such separates? A working library of separates saves wear and tear on bound volumes. It is also very convenient, in field work, to have separates covering the work in hand. By all means let us have separates in adequate supply, *but* is it necessary to broadcast them? It happens frequently when this is done that years after the separates have been sent out and the supply exhausted, urgent and worthwhile requests for the publication continue to come in.

Personally, I do not feel as some do, that I have been slighted, if I do not get separates of articles which have appeared in the Journal of Mammalogy, *provided* I know a separate can be had, upon request, from the author. Everyone dislikes the worker who is "tight" with his separates but I believe that much of the money that we now spend in "broadcasting" our separates might be put to better use.

Yours truly,

JOSEPH DIXON.

Museum of Vertebrate Zoology,
Berkeley, California,
November 23, 1926.

## COMMENT AND NEWS

By authority of the Governor General of Canada in Council, dated January 5, 1927, the museum branch of the Department of Mines at Ottawa has been designated the "National Museum of Canada." The museum was started as part of the Geological and Natural History Survey of Canada in 1843 and was later known as the Museum of the Geological Survey of Canada. On moving into the new "Victoria Memorial Museum" building in 1910 the museum became generally known as the Victoria Memorial Museum, under the auspices of the Geological Survey. In 1921 it was created a separate branch of the Department of Mines where it still remains under the new official designation.